Chapter Five

Evidence on Travel Behavior of Transit-Supportive Residential Neighborhoods

1. Introduction

This chapter, like the last, examines the relationship between physical design and travel behavior in suburban settings; here, however, the analysis is at a more aggregate scale. Specifically, this chapter compares travel choices between two different types of suburban neighborhoods— older, more traditional transit-oriented areas (hereafter referred to as "Transit neighborhoods") and newer, more auto-oriented ones ("Auto neighborhoods"). Empirical investigations are conducted for these two types of neighborhoods in California's two major conurbations- the Los Angeles region and the San Francisco Bay Area.

By conducting investigations at the neighborhood scale, insights can be gained into how density, land-use mixtures, road layouts, and other basic physical characteristics of areas shape travel behavior, insights which are elusive at the micro-design level. Consequently, this chapter focuses more on neighborhoods, rather than on individual sites and buildings as in the previous chapter. Methodologically, these chapters are similar; both use paired comparisons to infer how features of the built environment influence travel behavior. A more sophisticated approach is adopted in this chapter, however, by introducing several control variables that allow the unique influences of the built environment to be better isolated. This chapter also differs from the previous one in that it focuses primarily on residential, instead of office developments, and in that it also examines older, existing neighborhoods, not just newly built ones.

2. What We Know about Travel Behavior in Neotraditional Neighborhoods

The history of city building in the United States since World War II is largely the history of suburban development in the era of the freeway. This type of development introduced new concepts into the realm of urban building. New parts of metropolitan areas were conceived of as discrete developments; residential areas were solely residential, industrial areas solely industrial, and commercial areas given over entirely to retail activities. The only link between these areas was the hierarchically designed -and almost exclusively automobile-centric — road network. At the top of this hierarchy was the limited-access highway, made ubiquitous in the U.S. by the Interstate Highway Act of 1956. On the other end of the hierarchy was the local street, epitomized in residential neighborhoods by the cul-de-sac. If the freeway or expressway was designed to allow the highest volume of traffic to pass at the highest speeds possible, the cul-de-sac was designed to minimize traffic volume and keep it slow.

In the course of the past ten years, this form of development has increasingly come under criticism from architects, urban planners, environmentalists, and even some developers as being “unsustainable.” Depending upon the viewpoint of the critic, this automobile-oriented, largely suburban development is too consumptive of land, too costly in terms of long-range infrastructure supply and maintenance, too disruptive of traditional urban and social fabric, and too limiting in the lifestyle choices it allows. One of these limited lifestyle choices that has come under increasingly close watch is travel behavior. Critics of automobile-oriented development argue that our society has become so obsessed with the production of efficiency in automobile movement that it has built transportation choices right out of the environment. For example, the cul-de-sac represents an advance in design efficiency of automobile movement— and also of protection from automobiles- but a step backwards in design efficiency for pedestrian or transit movement; pedestrians often need to walkexceedingly long distances because through-paths are cut off by cul-de-sacs, and transit vehicles cannot serve cul-de-sacs or efficiently filter through neighborhoods with curvilinear layouts or branch roads. Many modern suburbs, therefore, eliminate options in travel choice by physically designing out any but the automobile option.

As discussed in Chapter Two, a number of contemporary urban planners and designers, such as Elizabeth Plater-Zyberk, Andres Duany, and Peter Calthorpe, argue that we need to move toward building more integrated suburban neighborhoods. Undoing the rigid street hierarchy, returning to more conventional gridiron and radial street forms, narrowing street widths and allowable building setbacks, and landscaping for pedestrian scale will all serve to eliminate the dominance of the automobile in the built form and thereby reduce dependence on it. Calthorpe's Laguna West, for example, in the suburbs of Sacramento, uses radial and gridiron street patterns and minimizes (although does not eliminate entirely) the use of cul-de-sacs in an effort to focus the neighborhoods around transit stops and centers. Similarly, Duany/Plater-Zyberk's plan for the Kentlands, Maryland, provides a network of through streets which enhances both pedestrian and transit vehicle permeability. Through these and other types of neotraditional design schemes, the proponents argue, drive-alone trips and automobile dependency will be reduced.

Unfortunately for researchers trying to substantiate or refute these claims, projects which incorporate these principals are either unbuilt or too new to evaluate. It is, therefore, impossible to empirically test the assertion that neotraditional and other neighborhood types that challenge the logic of automobile-dominated suburban form actually do affect levels of transit use or pedestrian activities. In the absence of such hard-number examples, research has tended to polarize into two methodological approaches.

2.1. Simulation Studies

As mentioned in Chapter Two, a number of studies have attempted to use advanced transportation/land-use modeling techniques to forecast what travel behavior would look like in a hypothetical neotraditional world. Kulash (1990) used the standard UTPS travel demand models to simulate neighborhood forms, concluding that neotraditional design reduces average daily VMT by 57 percent relative to standard 1970s-style PUDs. The White Mountain Survey Company (1991) completed a similar study of Portsmouth, New Hampshire, in an effort to derive reliable trip generation rates for two neotraditional communities, which they found to be substantially below the norm.

Two larger modeling studies of transit-oriented development have recently been completed: the Middlesex Somerset Mercer Regional Council modeling project (MSM, 1992) and the Friends of Oregon modeling project (LUTRAQ, 1992). The MSM project modeled travel demand for three high-density, mixed-use center alternatives for the central New Jersey corridor between Trenton and New Brunswick, each of them incorporating neotraditional design principals. They then ran growth models for each alternative, projected to 2010, based on two scenarios[1], and compared the projections to current trends. All alternatives and scenarios showed substantial reductions in VMT over an extrapolation of existing trends.

The Friends of Oregon's Land Use Transportation Air Quality (LUTRAQ, 1992) study similarly modeled a growth corridor to the west of Portland, Oregon, to the year 2010. The model projected growth around a proposed freeway through the corridor. The researchers then presented a number of alternatives, including both a no-build alternative and a light-rail with neotraditional development alternative. The latter, when modeled to the projection year, showed a VMT rate that was 35 percent below that of the freeway alternative. The LUTRAQ report is particularly noteworthy because it provides detailed neotraditional design recommendations for a wide variety of different neighborhood types, and accounts for those differences in its projections.

2.2, Previous Empirical Research

The other direction of research in the absence of hard examples of neotraditional development has been to try to extract evidence from the existing built form- that is, to use "traditional" neighborhoods as a proxy for what "neotraditional" neighborhoods might look like. Several researchers have tried to do this on a macro-scale. Newman and Kenworthy (1989), for example, have looked globally at the correlation between urban density and fuel consumption, concluding that low-density cities average four to five times more fuel consumption per capita as high-density ones with good transit services. Similarly, Holtzclaw (1991) has tried to extract evidence of the influence of residential neighborhood design on travel behavior by looking broadly at neighborhoods in the San Francisco Bay Area. Both of these endeavors, however, look at neighborhoods that are too fundamentally different in too many ways to be useful in providing evidence at the neighborhood level of the impact of design on travel behavior.

In this chapter, an effort is made to examine strictly controlled and closely paired neighborhoods at a medium scale to illuminate the degree to which design and land-use features impact travel behavior. Our goal is to compare carefully selected neighborhoods which match tightly designed control criteria, but which differ in the ways advocates of neotraditionalism argue that well-designed neighborhoods should differ from auto-oriented ones.

As noted in Chapter Two, several recent studies have begun to look at how the physical designs of neighborhoods impact suburban residential mobility. Handy (1992) has evaluated shopping trips made by residents of four neighborhoods in the San Francisco Bay Area, categorized by levels of "accessibility." She identifies two types of accessibility, regional and local; neighborhoods of high local accessibility correspond to traditional, streetcar neighborhoods, what we call "Transit neighborhoods" in this chapter. She found that residents of high local-accessibility neighborhoods tended to walk to the store more than residents of low local accessibility (auto-oriented) neighborhoods. She did not, however, analyze transit in her study.

Fehr and Peers Associates have analyzed modal choice by neighborhood type using data from the 1980 Bay Area Transportation Survey (BATS), conducted by the Metropolitan Transportation Commission. They were able to show higher transit and pedestrian rates and lower drive-alone rates for the "Traditional" community versus the "Suburban" community. While these results suggest a tendency for Transit neighborhoods to have higher walking and transit rates, their method of analysis was a grouped comparison; consequently, they were not able to control for extraneous factors, such as area median income, which might affect the numbers. Furthermore, since the results are based on 1981 BATS data, where sample sizes at the disaggregate level tended to be very small, the mode shares given are of questionable statistical significance.

Another informative study was recently completed in Montgomery County, Maryland, for the Maryland National Park and Planning Commission (1992). Simple comparisons were drawn of 1980 journey-to-work modal shares between traditional neighborhoods along a commuter rail line and adjacent, auto-oriented neighborhoods off the line. Their data showed a tendency for residents of "Transit and Pedestrian Neighborhoods" to drive alone to work less and to use transit more. Again, however, the neighborhoods were not controlled for additional factors, most notably income.

3. Methodology

The remainder of this chapter compares "Transit" and "Auto" neighborhoods in California's two largest metropolitan areas: the Los Angeles/Orange County and the San Francisco Bay CMSAs. Matched pairs were used to discern differences in commuting behavior between Transit and Auto neighborhoods, while controlling for confounding variables. "Transit neighborhoods" were defined as follows?

- initially built along a streetcar line or around a rail station;
- primarily gridded (over 50 percent of intersections 4-way or 'X' intersections);
- laid out and largely built up prior to 1945.

"Auto neighborhoods," on the other hand, were defined as:

- laid out without regard to transit, generally in areas without transit lines, either present or past;
- primarily random street patterns (over 50 percent of intersections either 3-way "T" intersections, or cul-de-sacs);
- laid out and built up after 1945.

The first step of our research methodology was to identify candidate Transit neighborhoods for both of the metropolitan areas. This was done by comparing contemporary street maps with historical railroad and streetcar maps. Where gridiron or radial street patterns from the street map lined up with rail or street car lines from the streetcar and railroad map (and particularly where two or more of these lines crossed), we noted a potential "traditional" neighborhood. We narrowed down this list of potential neighborhoods through both windshield surveys and discussions with planners and others familiar with the neighborhoods.

Next, for each of the Transit neighborhoods, we attempted to find a matching Auto neighborhood. Two sets of criteria were used to find the matches. First, three control criteria were used—variables on which the Auto neighborhood should not vary from those of the Transit neighborhood. For each Transit neighborhood, an Auto neighborhood needed to:

- have no more than 10 percent variation of median household income from the Transit neighborhood;
- have reasonably comparable intensities and types of transit service available as in the Transit neighborhood;
- have reasonably similar topographic and other natural features as the Transit neighborhood; and
- be no more than 4 miles from the center of the Transit neighborhood.

Second, a list of differentiation criteria- those variables by which the Auto neighborhood must (by definition) differ from the Transit neighborhood- was established. The Auto neighborhood must:

- have a significantly lower percentage of 4-way, cross-intersections than the Transit neighborhood; and
- have net residentialdensities equal to or less than those of the Transit neighborhood.

After applying these criteria, the number of candidate neighborhood pairs in both metropolitan areas was whittled down considerably- from over 400 to just 7 in the San Francisco Bay Area, and from over 700 to just 6 in the Los Angeles-Orange County region.

3. 1. Study Criteria

Since the strictness of these criteria sharply reduced the number of candidate Auto neighborhoods, it is instructive to explain in some detail the rationale for each of them.

(1) No more than 10 percent variation of median household income from the Transit neighborhood

It has been well established that mode choice is highly correlated with income. It is essential, then, that neighborhoods be matched in terms of median income to remove this confounding influence (Kanafani, 1983; Meyer and Gomez-Ibanez, 1981).

(2) Reasonably comparable levels and types of transit service available as in the Transit neighborhood

This criterion is of utmost importance, although it is problematic in that it touches on the muddy issue of cause and effect in transit provision. We found that the Transit neighborhoods naturally had greater levels of transit service; they were, after all, laid out for transit. It is therefore difficult to assess whether these neighborhoods have more frequent transit service because they have more transit users (demand-driven) or because transit operators simply find them more efficient through which to operate (supply-driven)[3] We sought to pair neighborhoods that had less than a 50 percent difference in the transit intensity indicator, although many of the neighborhood pairs, particularly in Los Angeles, admittedly have larger differentials! Where they do exceed 50 percent difference in the intensity indicator, this is noted in the neighborhood description.

(3) Reasonably similar topographic and other naturalfeatures as *the Transit neighborhood*

This criterion was based on the assumption that topographic characteristics of a neighborhood influence travel behavior independent of neighborhood design.

(4) No more than 4-mile distance between centroids of the matchedpairs

Transit usage is most reliably compared between areas of close physical proximity. Neighborhoods that are far from each other, even if all socio-economic data match up reasonably well, are likely to experience different regional affiliations and historical contexts, which can affect mode choice in ways that are too difficult to take into account.5

(5) Net residential densities equal *to or less than those of the Transit neighborhood*

Critics of post-war suburban housing development have generally argued that current suburban densities are too low to support transit. Previous studies suggest that densities of 12 dwelling units to the acre are the minimum necessary to sustain basic transit of 15-minute headways or less (Pushkarev and Zupan, 1977). We assume, therefore, that transit-oriented developments will, in general, be planned with net residential densities higher than today's standards. Consequently, we looked for Transit neighborhoods with densities higher than Auto neighborhoods. In order not to overly constrain the analysis, however, threshold criteria were not set for net residential density for either the Transit- or the Auto-neighborhoods.6

3.2. Process of Neighborhood Elimination

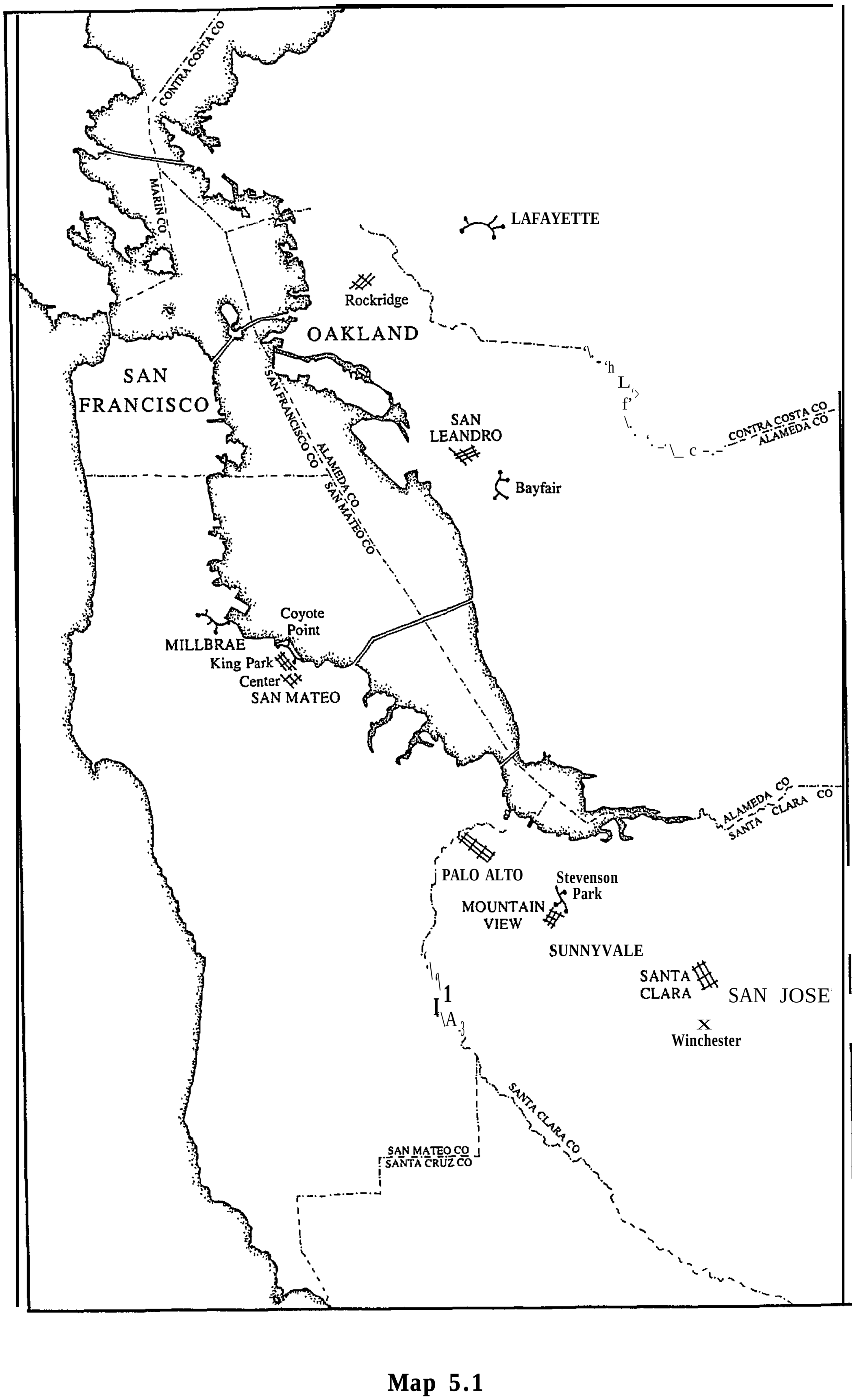
Using both the control and the differentiation criteria, matches were found through a process of elimination. Many Transit neighborhoods were eliminated from consideration because an appropriate match could not be found.7 All of the matches met our income criterion, but some did not strictly adhere to the transit service intensity criterion. Strict adherence to this criterion would have produced practically no pairs to evaluate. Pairs that violate criteria are marked, and explanations why it is important to include them are given.8

4. Case Results: San Francisco

4.1. San Francisco Pair Descriptions

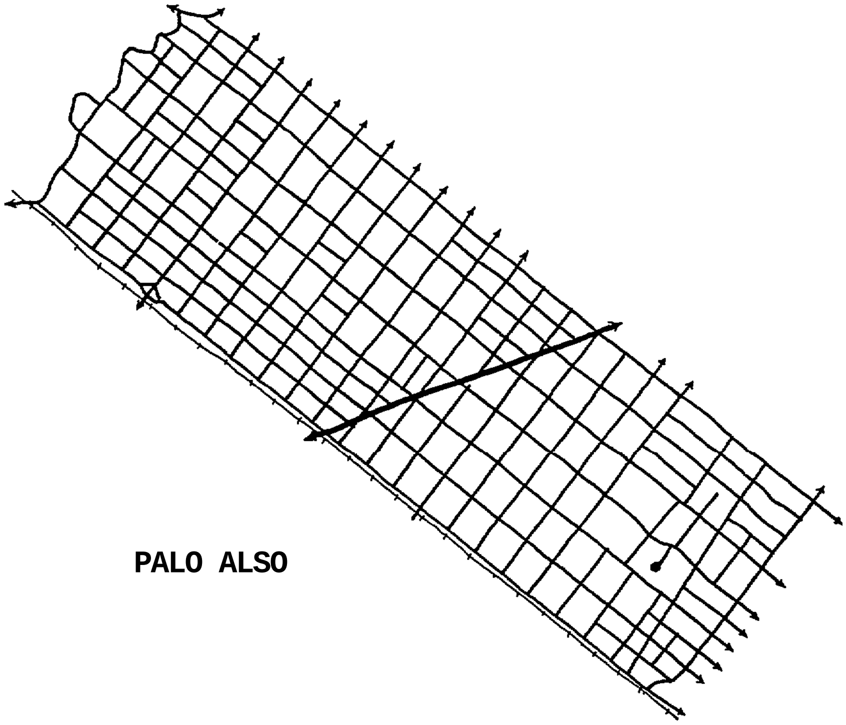
Seven matched pairs for the San Francisco Bay Area, and six for the Los Angeles area, were found. The Bay Area neighborhoods varied in geometric size from 1/4 square mile to a little over 2% square miles. Neighborhood population ranged from 2,000 to 10,500 people living in the neighborhood. The geographic locations of the matched pairs are shown in Map 5.1.

- *Palo A&o/Stevenson Park:* Downtown Palo Alto was paired with the Stevenson School Park district of MountainView (see Map 5.2). These areas are highly comparable- there is only about a 4 percent difference in median income between them, and both have comparable levels of bus service. In addition, both have Caltrain (commuter rail) stations immediately adjacent to them.
- *Santa Clara/San Jose-Winchester:* Central Santa Clara was paired with a portion of San Jose immediately adjacent to the Winchester Mystery House 10 (see Map 5.3). Both of these neighborhoods are also highly comparable. There is only a 7 percent difference in median income, and both neighborhoods have comparable levels of bus service. Although a portion of the Santa Clara study area lies within 1/4 mile of a Caltrain station while the San Jose-Winchester neighborhood does not, very little of the Santa Clara study area can be said to be within walking distance of that station. Caltrain passengers from both areas would need to arrive at the station via another mode.
- *San Mateo Center/San Mateo-Bayshore Point:* Central San Mateo was paired with the neighborhood east of the 101 Freeway just south of the San Mateo Golf Course11 (see Map 5.4). Both areas line up well according to income, with only a 4 percent difference between them. However, there is a roughly53 percent difference in the level of transit intensity between them.
- *Rockridge/Layayette:* The Rockridge neighborhood of Oakland was compared with Lafayette12 (see Map 5.5). Rockridge is actually very traditional in its feel, but, because it is built adjacent to a slope, it has as many T as cross-intersections. The two neighborhoods are roughly five miles apart, a distance which is admittedly long. It was felt, however, that it was important to have at least one pair comparing similar incomes on both sides of the Oakland hills. The Lafayette neighborhood, because of census tract demarcations, is rather large, physically. This is not problematic for purposes of comparison, however, since the bulk of the residential units in this tract are clustered in



Map 5.1

Location of Paired Neighborhoods for the San Francisco Bay Area



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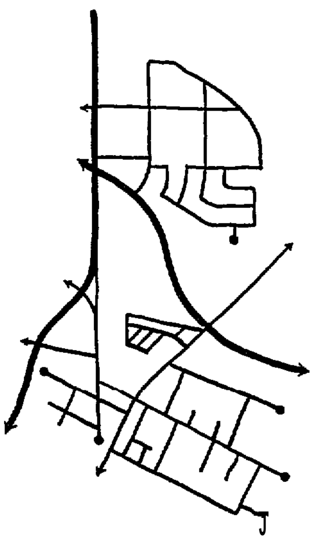
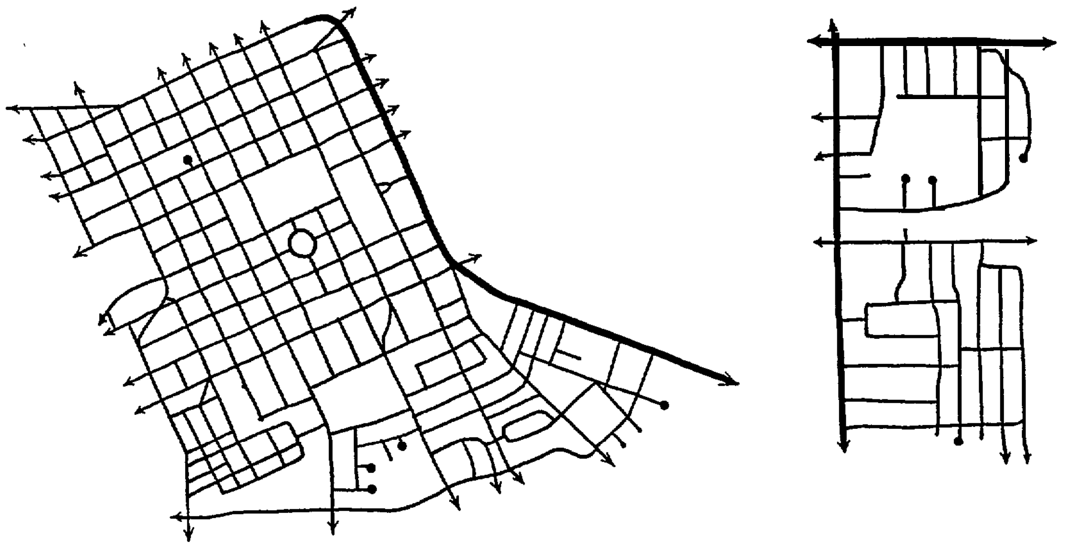


MOUNTAIN VIEW--Stevenson Park

Map 5.2

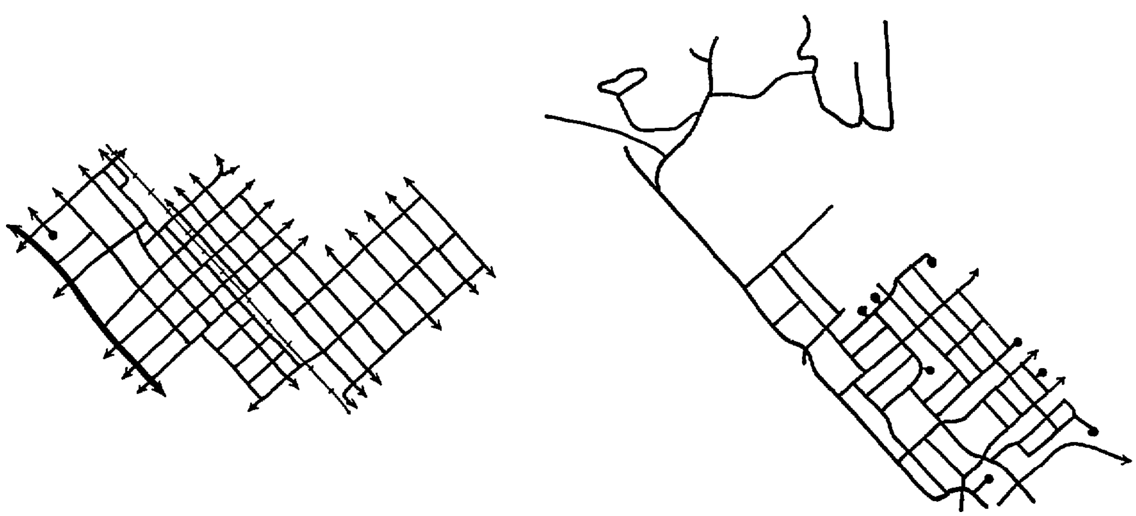
Palo Alto and Mountain View-Stevenson Park Pair



SANTA CLARA   SAN JOSE--Winchester

Map 5.3

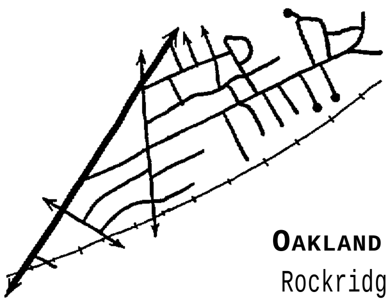
Santa Clara and San Jose-Winchester Pair

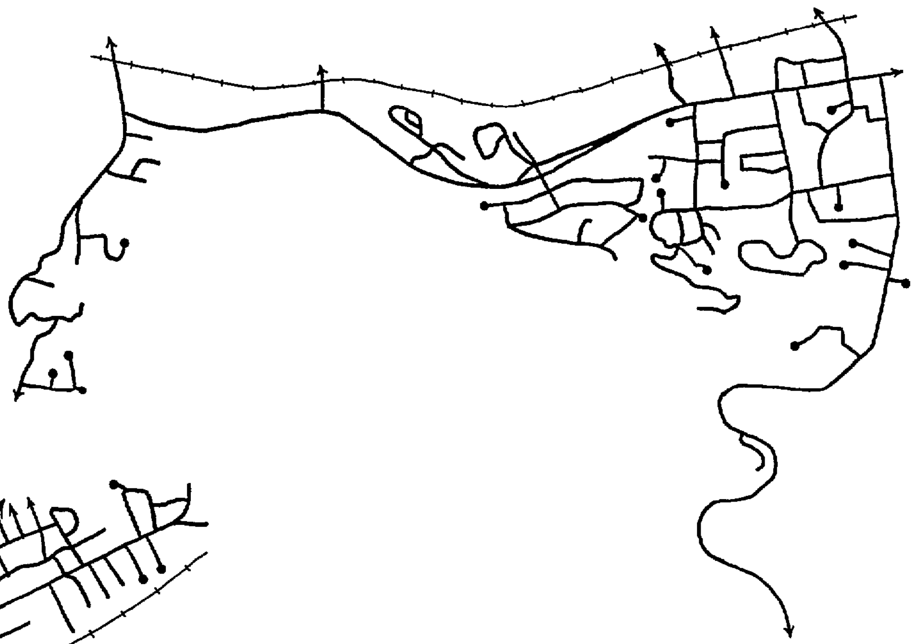


SAN MATEO--Center   SAN MATEO--Coyote Point

Map 5.4

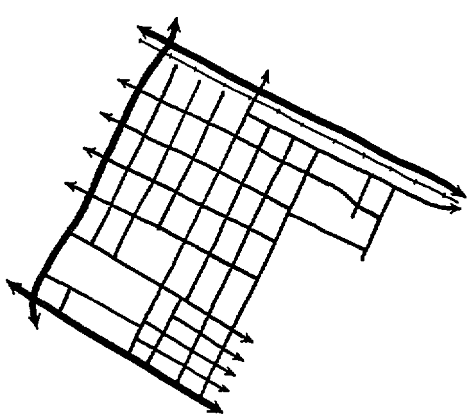
San Mateo-Center and San Mateo-Coyote Point Pair

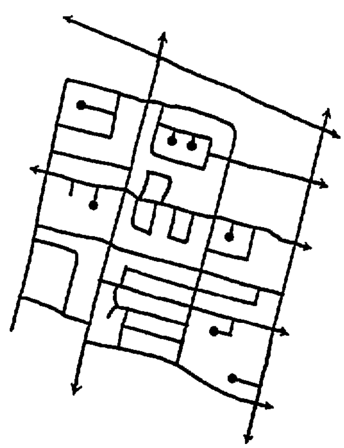




Map 5.5

Oakland-Rockridge and Lafayette Pair





Map 5.6

Mountain View-Center and Sunnyvale-Mary Avenue Pair

the quadrant of the tract near the BART station, providing a residential cluster only slightly larger than the Rockridge neighborhood.

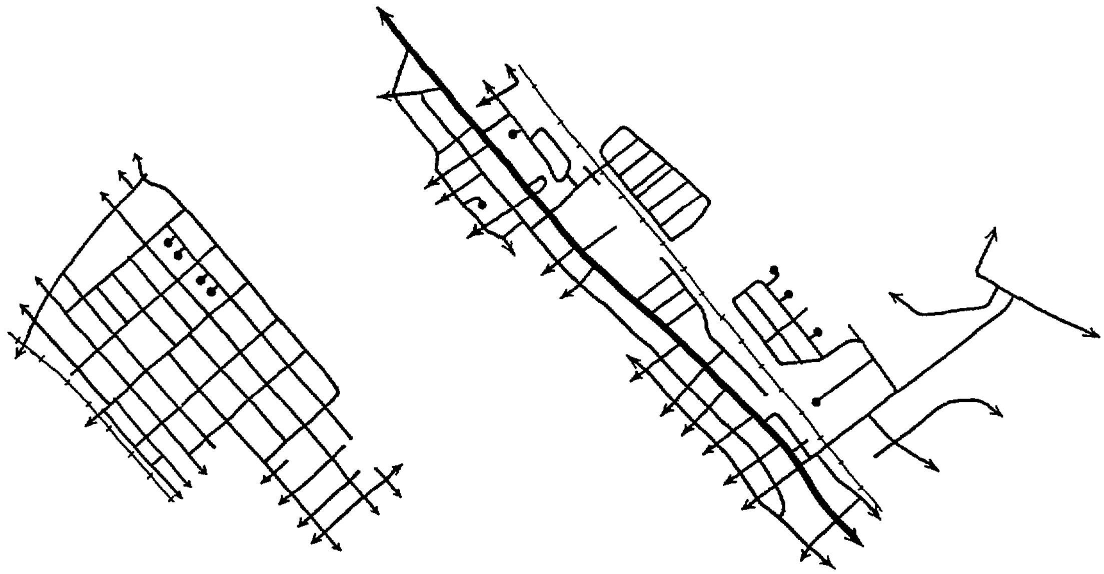
- *Mountain View (Downtown)/Sunnyvake-Ma* y *Avenue:* The downtown area of Mountain View was paired with a neighborhood of Sunnyvale just north of Mary Avenue13 (see Map 5.6). The areas are comparable, although the Sunnyvale neighborhood has a slightly higher net residential density than Mountain View. Also, the Sunnyvale neighborhood is not adjacent to a Caltrain station.
- San *Mateo-King Park/Millbrae:* A second neighborhood of downtown San Mateo, with a lower median income than the first, was compared with an area of Milbrae between the Caltrain station and San Francisco International Airport14 (see Map 5.7). These two neighborhoods are highly comparable, and are served by both rail and bus.
- *San Leandro/Bayfair"* Central San Leandro was compared with the area immediately adjacent to the Bayfair BART15 (see Map 5.8). The areas match up together in virtually all respects, including transit service intensity and type, and are therefore ideal comparisons.

4.2. San Francisco Area Results

Tables 5.1 and 5.2 summarize the control and differentiation criteria for the San Francisco Bay Area. Overall, neighborhoods match closely in terms of median incomes and transit service types, though Transit neighborhoods tend to enjoy more intensive bus services. Also, neighborhoods tend to differ sizably on differentiation criteria Transit neighborhoods have 35-50 percent more four-way intersections and in seven of the eight pairs have higher residential densities.

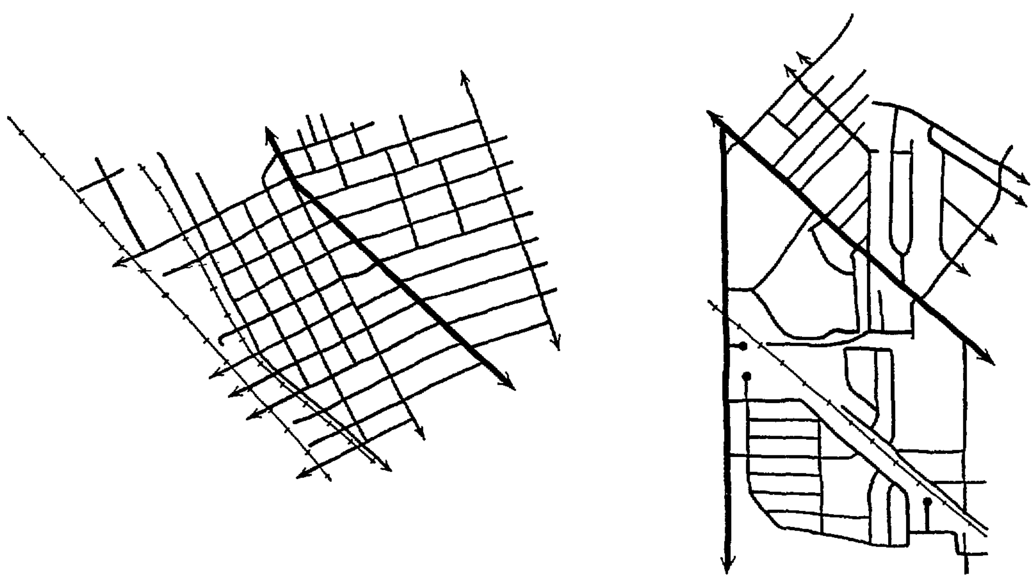
The modal shares and trip generation rates for matched-pairs are presented in Tables 5.3 and 5.4, and summarized in Figures 5.1 through 5.4. All data are for 1990 work trips by place of residence. Particular attention should be paid to the Palo Alto/MountainView, the Santa Clara/San Jose-Winchester, and the San Leandro/Bayfair matches, since these meet the study criteria in all respects.

These results show significantly higher pedestrian mode shares and trip generation rates in all cases for work trips in Transit neighborhoods than in Auto neighborhoods. In addition, all Transit neighborhoods have lower automobile drive-alone modal shares and trip generation rates than Auto neighborhoods, in some cases, significantly lower. Moreover, all transit neighborhoods except Palo Alto generate more transit work trips and greater proportions of work trips made by transit than their Automobile counterparts. In all, the evidence is fairly persuasive for the selected Bay Area paired neighborhoods — controlling for income and to the extent possible, transit service levels, transit-oriented neighborhoods average far less solo-commuting than nearby auto-oriented neighborhoods.



Map 5.7

San Mateo-King Park and Millbrae Pair



Map 5.8

San Leandro and Bayfair Pair

Table 5.1

Characteristics of Bay Area Neighborhoods: Control Factors, 1990-92

Transit Neighborhood	Auto Neighborhood	Median Household Income TN	Median Household Income AN	Median Household Income % Difference	Bus Service in Daily VMT per Acre TN	Bus Service in Daily VMT per Acre AN	Bus Service in Daily VMT per Acre % Difference	Type of Transit Service TN	Type of Transit Service AN	Distance Between Centroids (in miles)
Palo Alto	Mountain View-Stevenson Park	47,500	45,486	4.2	0.27	0.23	11.8	"Bus, CR"	"Bus, CR"	3.50
Santa Clara	San Jose-Winchester	32,400	34,826	7.5	0.66	0.58	11.4	"Bus, CR"	Bus	2.00
San Mateo-Center	San Mateo-Bayshore/Point	37,159	38,873	4.6	0.47	0.22	53.3	"Bus, CR"	Bus	1.00
Oakland-Rockridge	Lafayette	46,512	43,108	7.3	1.43	0.12	91.5	"Bus, HR	"Bus, HR"	6.00
Downtown Mountainview	Sunnyvale-Mary Ave	40,379	40,398	0.1	0.71	0.51	29.3	"Bus. CR"	Bus	1.75
San Mateo-Ring Park	Millbrae	32,080	31,829	0.8	0.53	0.65	23.2	"Bus, CR"	"Bus, CR"	3.50
San Leandro	Bayfair	30,115	31,282	3.9	0.87	1.00	14.3	"Bus, HR	"Bus, HR"	2.00

Note: TN=Tmnsit Neighborhood; AN=Auto Neighborhood; CR=Commuter Rail; HR=Heavy Rail

Data Source: 1990 United States Census, STF-3A, and data from local tmnsit agencies.

Table 5.2

Characteristics of Bay Area Neighborhoods: Differentiation Criteria, 1990-92

Transit Neighborhood	Auto Neighborhood	% X Intersections TN	% X Intersections AN	% X Intersections %Differ-I	% Culde-Sacs TN	% Culde-Sacs AN	% Culde-Sacs % Difftr-ence	Net Residential Density (Dwelling Units per Acre) TN	Net Residential Density (Dwelling Units per Acre) AN	Net Residential Density (Dwelling Units per Acre) % Difference
Palo Alto	Mountain View-Stevenson Park	62.4	15.5	46.9	2.4	24.2	21.9	6.27	6.25	0.3
Santa Clara	San Jose-Winchester	63.6	28.3	35.3	3.5	18.9	15.4	6.18	4.03	53.3
San Mateo-Center	San Mateo-Bayshore/Foint	67.0	19.2	47.8	3.2	20.5	17.3	6.91	5.00	38.2
Oakland-Rockridge	Lafayette	44.7	9.6	35.1	10.5	4.0	6.5	5.32	2.12	150.9
Downtown Mountainview'	Sunnyvale-Mary Ave	69.8	32.1	37.7	3.2	19.6	16.4	7.08	8.31	17.4
San Mateo-Ring Park	Millbrae	65.9	29.0	36.9	5.5	19.6	14.1	6.89	5.09	35.4
San Leandro	Bayfair	64.5	26.1	38.4	5.4	10.2	4.8	7.34	5.94	23.6

Note: TN=Ttsnsit Neighborhood; AN=Auto Neighborhood

'Percentage point difference.

Data Source: 1990 United States Census, SIT-34 and field surveys.

Table 5.3

Comparison of Work Trip Modal Splits Among Bay Area Neighborhoods, 1990

Transit Neighborhood	Auto Neighborhood	Drive Alone % TN	Drive Alone % AN	Drive Alone % Difference*	Transit % TN	Transit % AN	Transit % Difference*	Pedestrian % TN	Pedestrian % AN	Pedestrian % Difference
Palo Alto	Mountain View-Stevenson Park	69.8	82.4	12.6	3.5	4.2	0.7	14.8	4.2	10.6
Santa Clara	San Jose-Winchester	70.1	84.3	14.2	3.7	1.4	2.3	13.4	2.9	10.5
San Mateo-Center	San Mateo-Bayshore/Point	71.9	73.9	2.0	9.5	5.1	4.4	5.3	2.1	3.2
Oakland-Rockridge	Lafayette	48.7	66.2	17.5	20.3	15.2	5.1	16.4	3.2	13.4
Downtown Mountainview	Sunnyvale-MaryAve	78.9	82.9	4.0	4.6	1.3	3.3	7.1	2.9	4.2
San Mateo-King Park	Millbrae	57.9	73.5	15.5	12.8	7.5	5.3	9.3	8.1	1.2
San Leandro	Bayfair	70.2	73.0	2.8	13.8	10.4	3.4	6.5	2.3	4.2

Note: TN=Transit Neighborhood An=Auto Neighborhood

***Percentage point difference**

Data source: 1990 US Census STF3-A

Table 5.4

Comparison of Work Trip Generation Rates Among Bay Area Neighborhoods, 1990

Transit Neighborhood	Auto Neighborhood	Drive-Alone Generation Rate** TN	Drive-Alone Generation Rate** AN	Drive-Alone Generation Rate** Difference	Transit Generation Data** TN	Transit Generation Data** AN	Transit Generation Data** Difference	Pedestrian Generation Rates** TN	Pedestrian Generation Rates** AN	Pedestrian Generation Rates** Difference
Palo Alto	Mountain View Stevenson Park	783	970	186	40	50	10	100	33	67
Santa Clara	San Jose Winchester	943	980	37	49	16	33	153	11	142
San Mateo-Center	San Mateo-Bayshore/Point	691	1,174	483	92	83	9	49	26	23
Oakland-Rockridge	Lafayette	669	855	187	278	197	81	79	32	46
Downtown Mountainview	Sunnnyvale Mary Ave	975	1,161	186	57	18	39	74	29	45
San Mateo-King Park	Millbrae	996	894	102	221	92	129	145	95	51
San Leandro	Bayfair	619	813	194	122	117	5	51	21	30

Note: TN=Transit Neighborhood; AN=Auto Neighborhood

**per one thousand housing units

Data Source: 1990 U.S. Census, ST F3-A

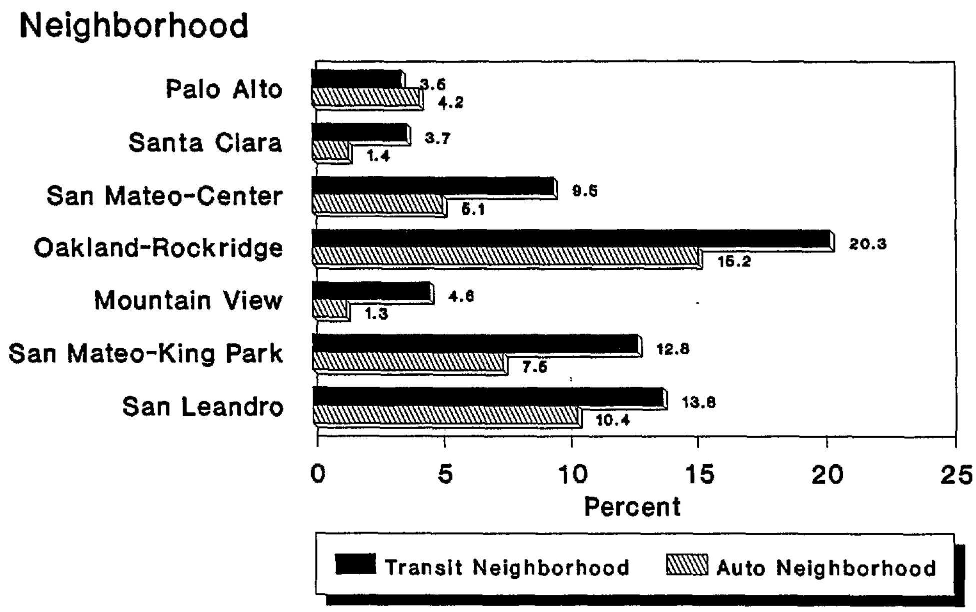


Figure 5.1

Neighborhood Comparisons of Transit Modal Splits, San Francisco Bay Area, 1990 Work Trips

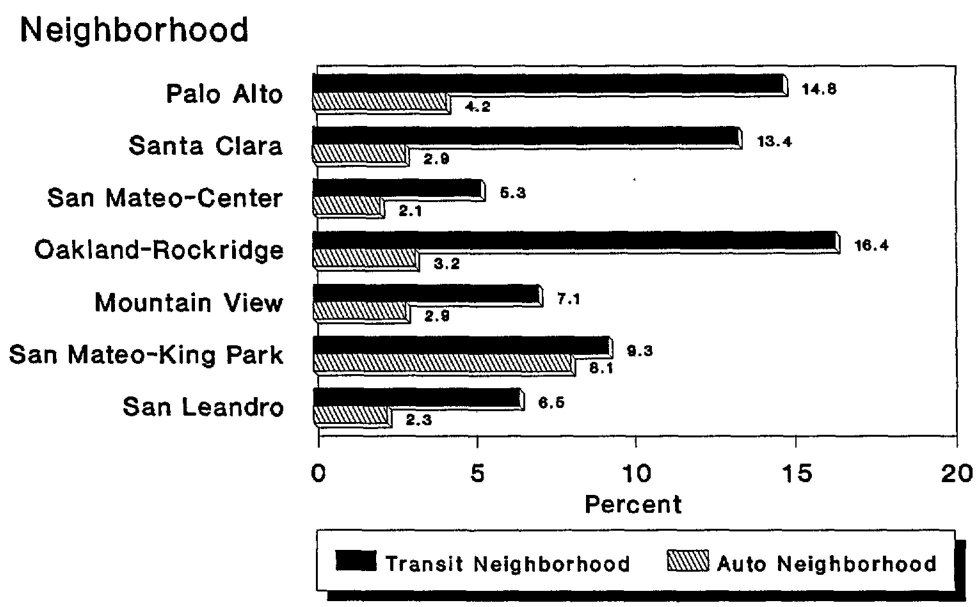
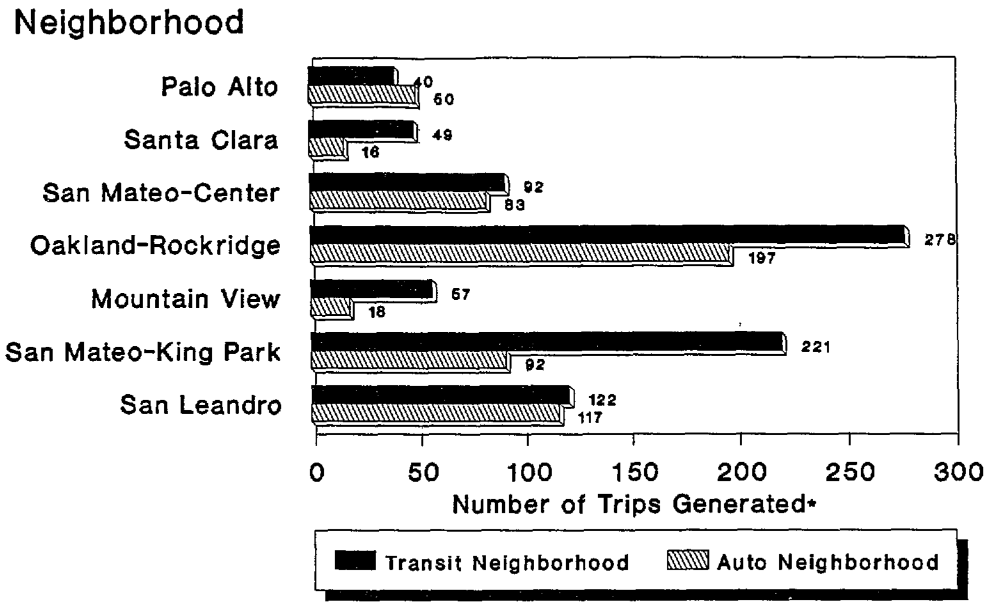


Figure 5.2

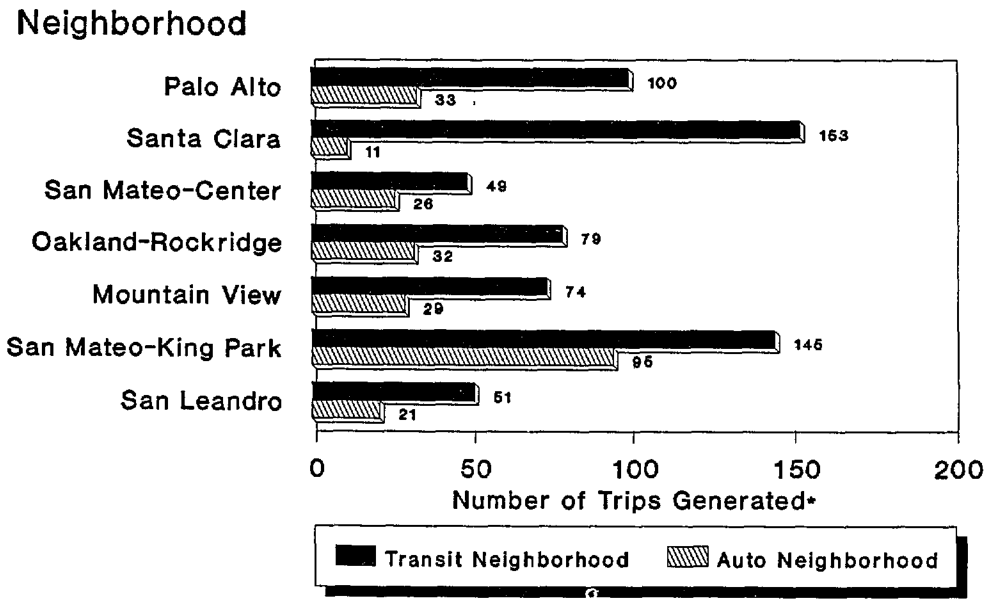
Neighborhood Comparisons of Walk and Bicycle Modal Splits, San Francisco Bay Area, 1990 Work Trips



* per 1,000 dwelling units

Figure 5.3

Neighborhood Comparisons of Transit Trip Generation Rates, San Francisco Bay Area, 1990 Work Trips



* per 1,000 dwelling units

Figure 5.4

Neighborhood Comparison of Walk/Bicycle Trip Generation Rates, San Francisco Bay Area, 1990 Work Trips

5. Case Results: Los Angeles

5.1. Los Angeles Pair Descriptions

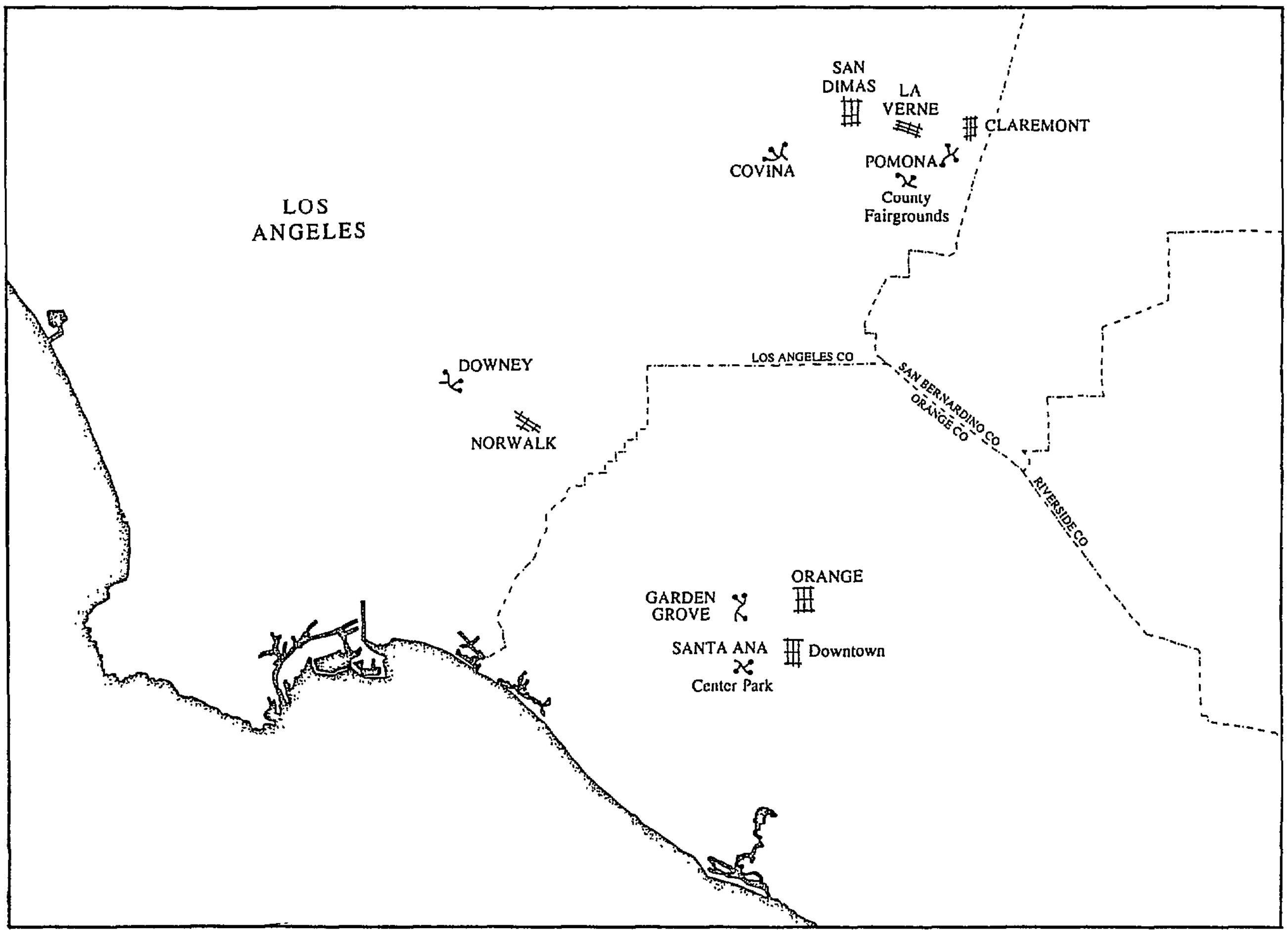
The Los Angeles neighborhoods are generally smaller than the San Francisco ones, all under a square mile in size. Neighborhood populations range from roughly 1,000 to 8,000 people. The locations of the Los Angeles pairs are shown in Map 5.9.

- *Santa Ana-Downtown/Santa Ana-Center Park:* An area adjacent to downtown SantaAna (between downtown and the Santa Ana train station) was paired up with another Santa Ana neighborhood roughly 21/4 miles away, grouped around Center Park[6] (see Map 5.10). The areas match up well on all criteria. There is only a 1.8 percent difference in median household income, and only an 8.8 percent difference in the transit intensity indicator.
- *Orange/Garden Grove:* The center of the city of Orange was matched up with a neighborhood in Garden Grove adjacent to (but not including) "The City" shopping center, roughly 2% miles away[17] (see Map 5.11). Again these neighborhoods match up well on all criteria. Photos 5.1 and 5.2 show residences in these two neighborhoods.
- *Norwalk/Downey;* CentralNorwalk was compared with a neighnothood in Downey located adjacent to Rockwell International's Space division[18] (see Map 5.12). The neighborhoods line up well in terms of differentiation and control criteria, except that Norwalk averages 40 percent more vehicle miles of bus service per acre.
- *La Verne/Pomona-County Fairgrounds:* Downtown La Verne was paired with a neighborhood in Pomona located about one-half mile south of the Los Angeles County Fairground[9] (see Map 5.13). The neighborhoods match up fairly closely on all criteria.
- *Claremont/Pomona-Palmares:* Central Claremont was compared with a neighborhood of Pomona adjacent to Pomona High Schol[20] (see Map 5.14). The neighborhoods pair well for all criteria except for transit service intensity, where the Transit neighborhood has 78 percent more bus service per acre than the Auto neighborhood.
- *San Dimas/Covina:* Downtown San Dimas was paired with a section of Covina near the Berkley Square shopping Center[21] (see Map 5.15). Again, these areas match up well on all criteria except bus service intensity, where the Transit neighborhood averages about 50 percent more service miles per acre than the Auto neighborhood.

5.2. Los Angeles Area Results

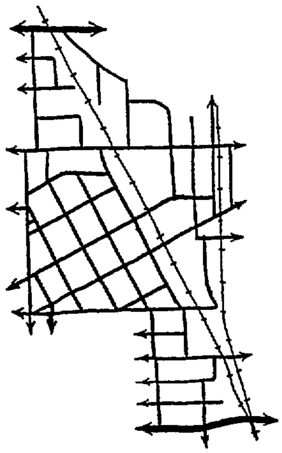
Tables 5.5 and 5.6 summarize the control and differentiation criteria for the six matched-pairs in the Los Angeles region. Overall, neighborhoods match closely on income and differ markedly in terms of road figurations. All Transit neighborhoods are denser than their Automobile peers (though in several cases only slightly). Transit service intensity again proved the most difficult factor to control.

Differences in work trip modal splits and trip generation rates are shown in Table 5.7 and 5.8, and summarized in Figures 5.5 through 5.8. These results are clearly more problematic than the San Francisco results. With the exception of La Verne, Transit neighborhoods have higher walking rates and lower drive-alone rates, for work trips, in terms of both the modal share and trip generation variables. However, impacts on transit commuting were less straightforward. Two of the Transit neighborhoods (La Verne and Claremont) had lower transit modal shares and trip generation

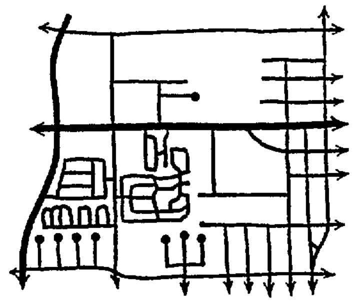


Map 5.9

Location of Paired Neighborhoods for the Los Angeles-Orange County Area



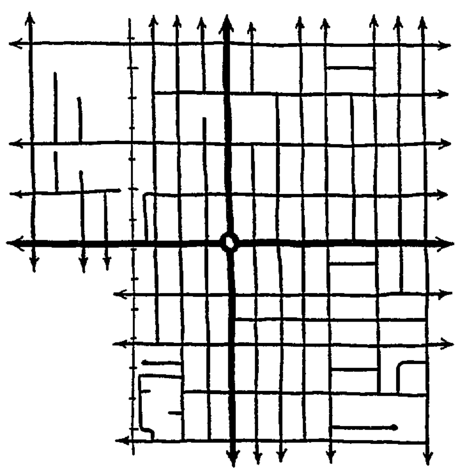
SANTA ANA--Downtown



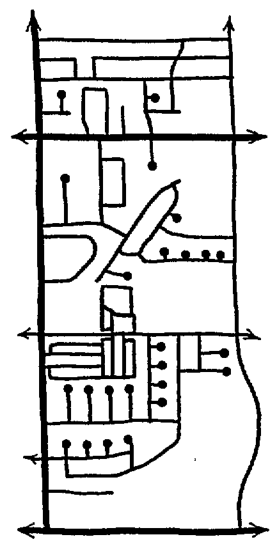
SANTA ANA--Center Park

Map 5.10

Santa Ana-Downtown and Santa Ana-Center Park Pair



ORANGE



GARDEN GROVE

Map 5.11

Orange and Garden Grove Pair

Photo 5.1

Garden Grove: Typical Automobile Residential Neighborhood in the Los Angeles Area (No Sidewalks)

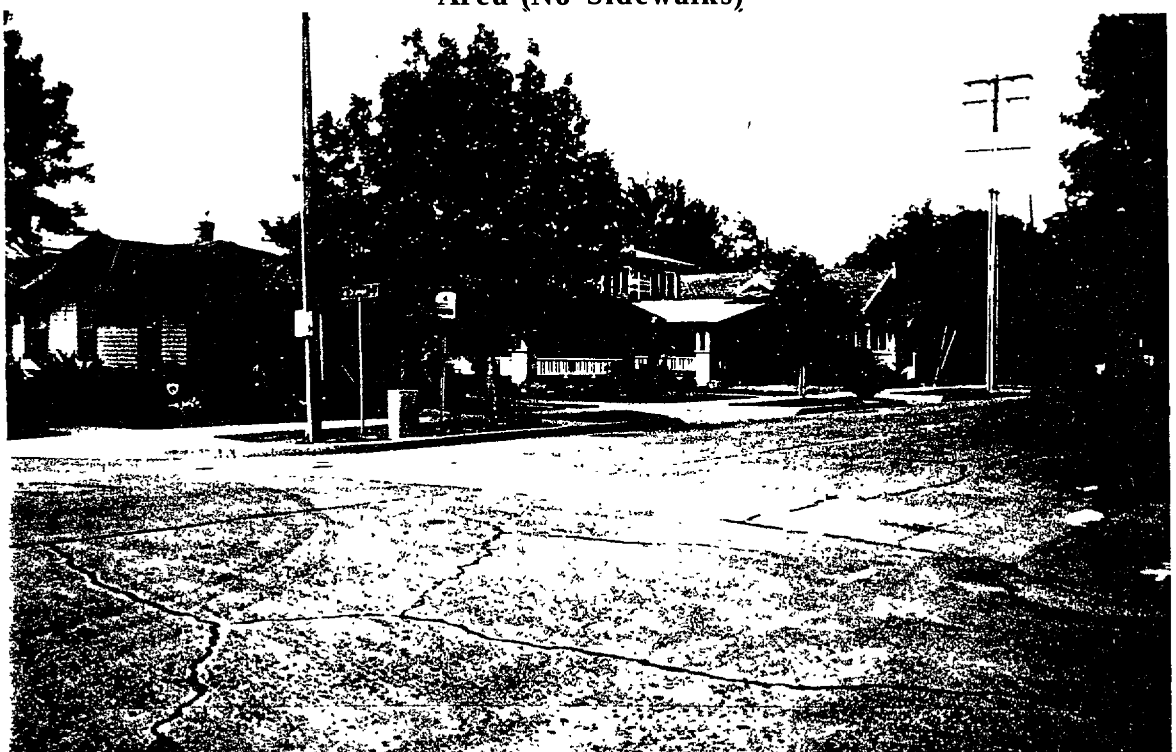
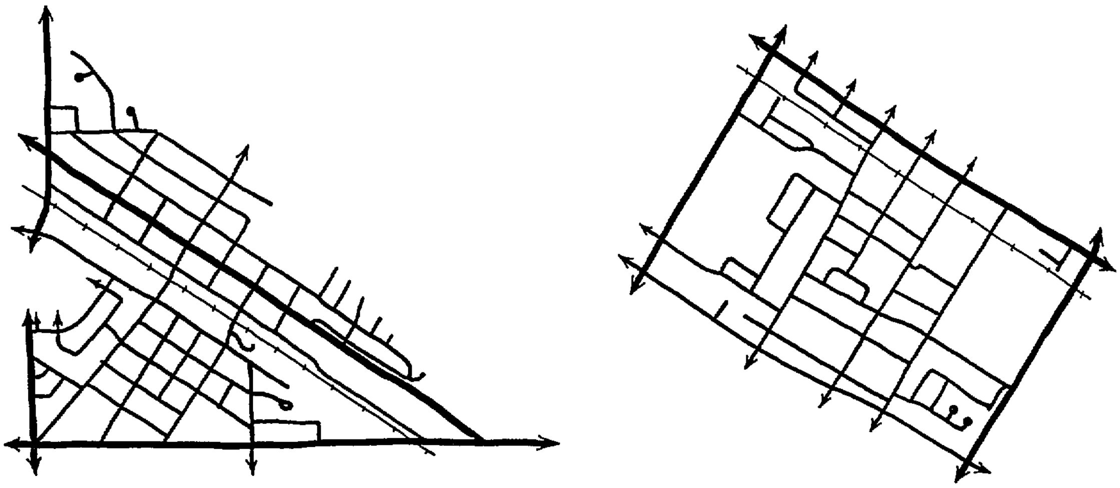


Photo 5.2

Orange City: Typical Transit Residential Neighborhood in the Los Angeles Area (Sidewalk; Transit Access)

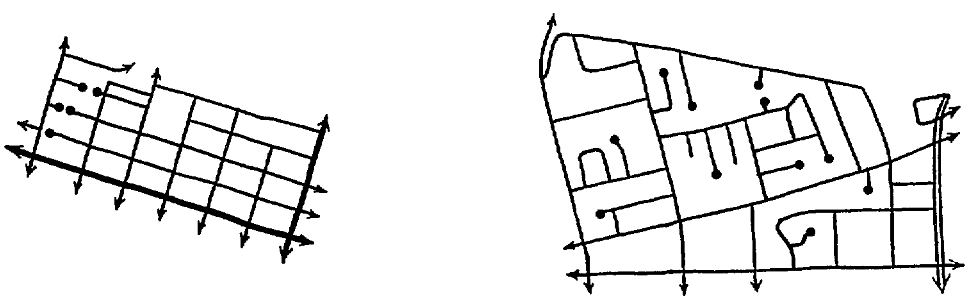


Norwalk

Downey

Map 5.12

Norwalk and Downey View Pair

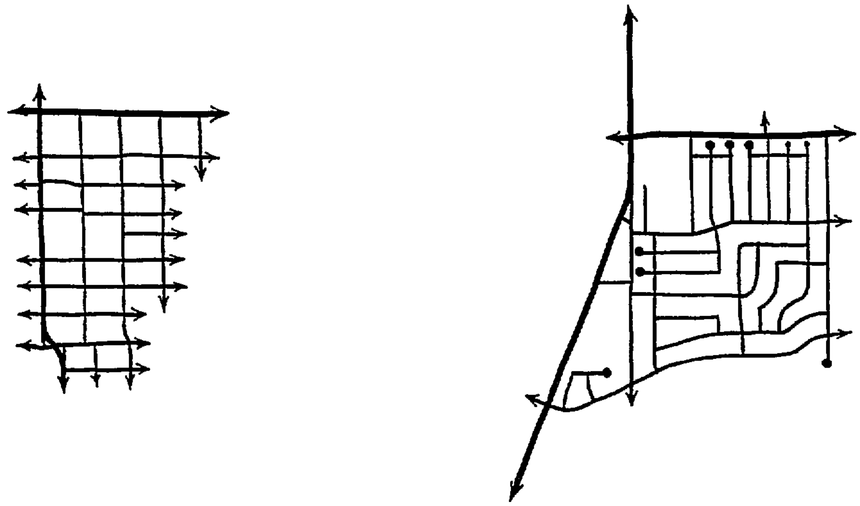


LA VERNE

POMONA--County Fairgrounds

Map 5.13

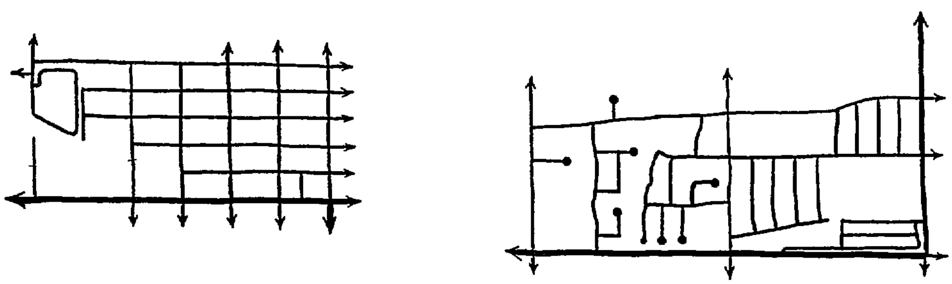
La Verne and Pomona-County Fairgrounds Pair



CLAREMONT POMONA

Map 5.14

Claremont and Pomona Pair



SAN DIMAS COVINA

Map 5.15

San Dimas and Covina Pair

Table 5.5

Characteristics of Los Angeles Area Neighborhoods: Control Factors, 1990-92

Transit Neighborhood	Auto Neighborhood	Median Household Income TN	Median Household Income AN	Median Household Income % Difference	Bus Service in Daily VMT per Acre TN	Bus Service in Daily VMT per Acre AN	Bus Service in Daily VMT per Acre % Difference	Type of Transit Service TN	Type of Transit Service AN	Distance Between Centroids (in miles)
Santa Ana	Santa Ana-Center Park	25,291	25,755	1.83	0.42	0.46	8.9	Bus	Bus	2.25
Orange	Garden Grove	32,848	33,627	2.37	0.25	0.18	25.4	Bus	Bus	2.75
Norwalk	Downey	27,500	30,215	9.87	0.42	0.25	39.9	Bus	Bus	3.50
La Verne	Pomona-County Fairgrounds	28,818	29,808	3.44	0.34	0.42	23.4	Bus	Bus	2.50
Claremont	Pomona-Palomares	31,477	29,702	5.64	0.84	0.18	77.7	Bus	Bus	1.62
San Dimas	Covina	36,201	36,121	0.22	0.40	0.20	49.9	Bus	Bus	3.50

Note: TN=Transit Neighborhood; AN=Auto Neighborhood

Sources: 1990 US Census, STF-3A, and data from local transit agencies.

Table 5.6

Characteristics of Los Angeles Area Neighborhoods: Differentiation Criteria, 1990-92

Transit Neighborhood	Auto Neighborhood	% X Intersections TN	% X Intersections AN	% X Intersections Difference1	% Cul-de-Sacs TN	% Cul-de-Sacs AN	% Cul-de-Sacs Difference	Net Residential Density (Dwelling Units per Acre) TN	Net Residential Density (Dwelling Units per Acre) AN	Net Residential Density (Dwelling Units per Acre) Difference1
Santa Ana	Santa Ana-Center Park	57.8	31.2	26.6	6.0	20.4	14.4	5.91	4.73	24.9
Orange	Garden Grove	72.9	13.1	59.8	5.6	25.3	19.7	7.01	6.97	5.7
Norwalk	Downey	43.9	27.8	16.1	9.2	2.0	3.3	6.56	6.03	8.8
La Verne	Pomona-County Fairgrounds	73.5	19.7	53.9	0.0	21.3	21.3	4.07	4.03	1.0
Claremont	Pomona-Palomares	7.0	23.9	46.1	0.0	21.1	21.1	4.77	4.14	15.2
San Dimas	Covina	73.3	18.8	54.5	10.0	2.0	9.8	8.24	6.38	29.2

Note: TN=Transit Neighborhood; AN=Auto Neighborhood

1Percentage point difference.

Source: 1990 US Census, STF-3A, and field surveys.

Table 5.7

Comparison of Work Trip Modal Splits Among Los Angeles Area Neighborhoods, 1990

Transit Neighborhood	Auto Neighborhood	Drive Alone % TN	Drive Alone % AN	Drive Alone % Difference*	Transit % TN	Transit % AN	Transit % Difference*	Pedestrian % TN	Pedestrian % AN	Pedestrian % Difference*
Santa Ana	Santa Ana-Center Park	38.9	53.2	14.3	16.8	9.6	7.8	5.6	1.0	4.6
Orange	Garden Grove	72.2	72.8	0.6	5.8	4.6	1.2	6.8	3.6	3.2
Norwalk	Downey	71.6	81.4	9.8	3.9	2.7	1.2	4.9	3.3	1.7
La Verne	Pomona-County Fairgrounds	77.1	69.3	7.8	1.0	3.5	2.5	2.3	7.5	5.2
Claremont	Pomona-Palomares	62.5	69.6	7.1	0.1	5.0	4.9	26.4	1.9	24.6
San Dimas	Covina	79.9	78.7	1.2	4.6	2.5	2.1	3.8	1.6	2.2

Note: TN=Transit Neighborhood; AN=Auto Neighborhood

***Percentage point difference.**

Data Source: 1990 US Census, STE3-A

Table 5.8

Comparison of Work Trip Generation Rates Among Los Angeles Area Neighborhoods, 1990

Transit Neighborhood	Auto Neighborhood	Drive Alone Generation Rate** TN	Drive Alone Generation Rate** AN	Drive Alone Generation Rate** Difference	Transit Generation Rate** TN	Transit Generation Rate** AN	Transit Generation Rate** Difference	Pedestrian Generation Rate** TN	Pedestrian Generation Rate** AN	Pedestrian Generation Rate** Difference
Santa Ana	Santa Ana-Center Park	807	941	134	349	158	191	84	12	73
Orange	Garden Grove	1,003	1,045	42	80	65	15	65	34	31
Norwalk	Downey	889	976	87	49	32	16	56	33	23
La Verne	Pomona-County Fairgrounds	846	995	150	10	72	61	25	26	1
Claremont	Pomona-Palomares	704	983	279	1	50	49	251	72	179
San Dimas	Covina	846	1,040	195	10	32	22	25	17	8

****work trips per 1,000 housing units**

Note: TN=Transit Neighborhood; AN=Auto Neighborhood

Source of Data: 1990 US Census, STF3-A

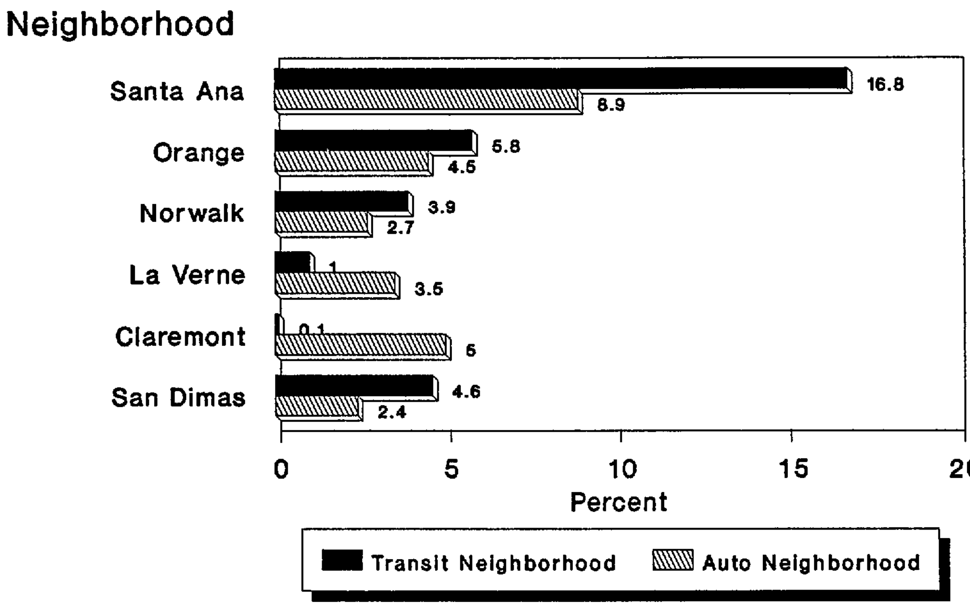


Figure 5.5

Neighborhood Comparisons of Transit Modal Splits, Los Angeles Region, 1990 Work Trips

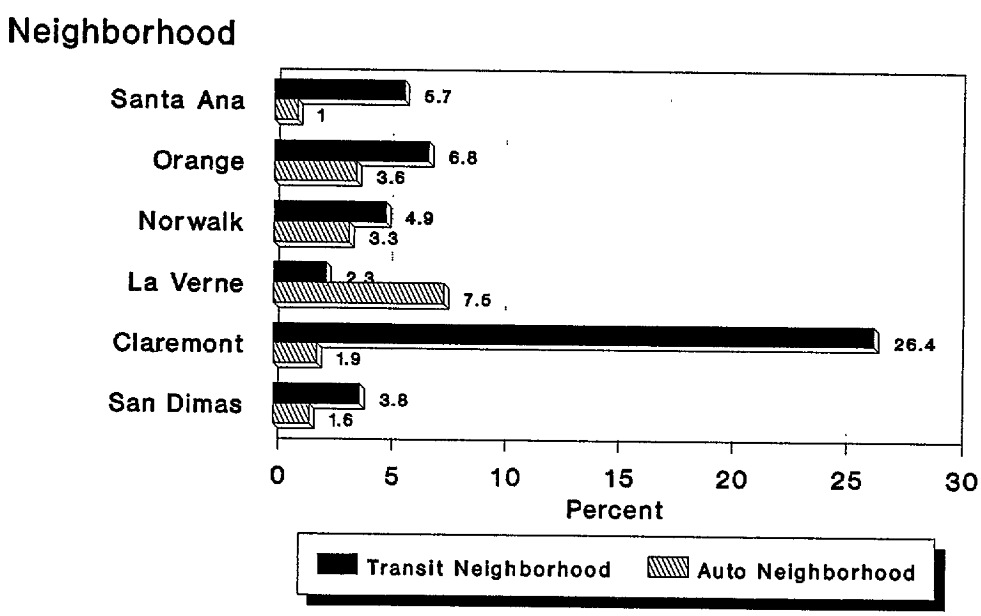
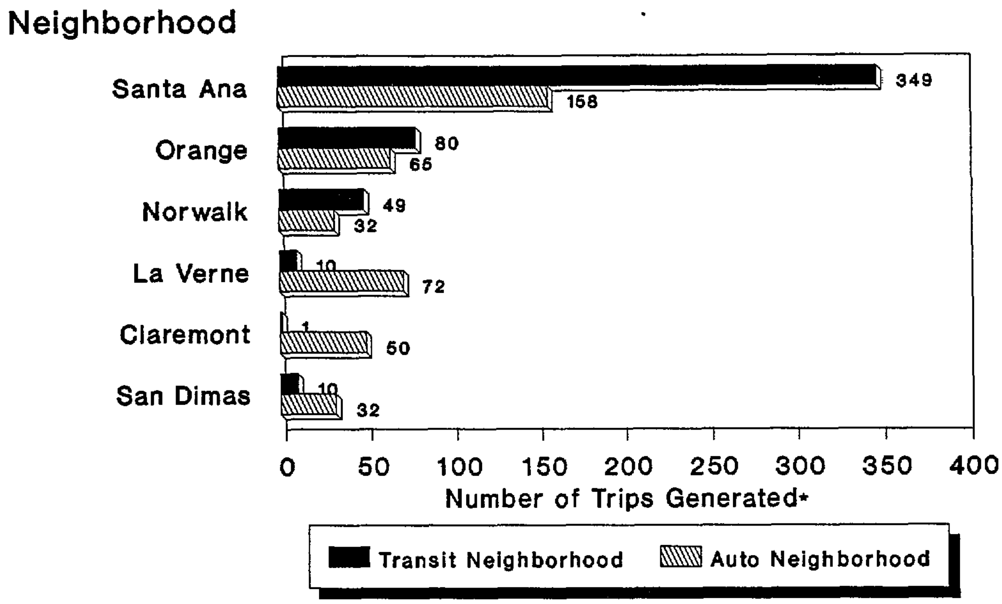


Figure 5.6

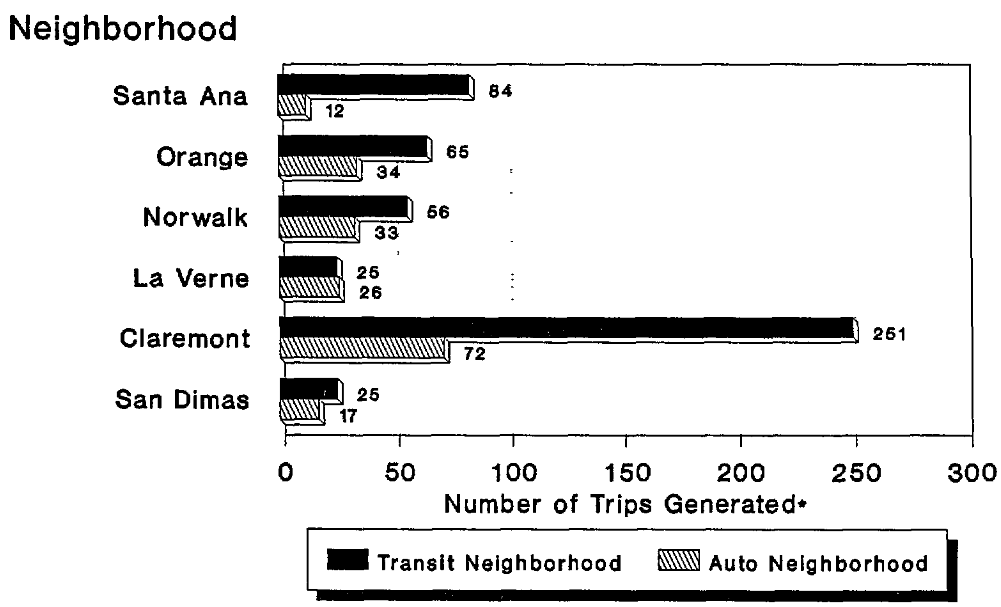
Neighborhood Comparisons of Walk and Bicycle Modal Splits, Los Angeles Region, 1990 Work Trips



* per 1,000 dwelling units

Figure 5.7

Neighborhood Comparisons of Transit Trip Generation Rates, Los Angeles Region, 1990 Work Trips



* per 1,000 dwelling units

Figure 5.8

Neighborhood Comparisons of Walk and Bicycle Trip Generation Rates, Los Angeles Region, 1990 Work Trips

rates than the paired Auto neighborhoods, and a third (San Dimas) had lower transit trip generation rates (although higher transit modal share) than its match. Ironically, two of these three have significantly higher transit service in the Transit neighborhood than in the Auto neighborhood. This would suggest that these neighborhoods are major trip attractors. In the case of Claremont, the existence of the College, as well as the very high pedestrian modal share (26 percent) bears this out to some degree; however, the explanation as to why transit performs so poorly in the other two neighborhoods is less clear.

Evidently, variables other than household income, road configurations, and residential densities account for these differences. One factor could be differences in bus service intensities, which as shown in Table 5.5 did not match up as closely as was hoped for. For example, the Transit neighborhood of LaVerne averaged 23 percent less bus service miles per acre than its paired Automobile neighborhood in Pomona, and perhaps as a result only had 1 percent of its residents commuting by bus, compared to 3.5 percent in the nearby Pomona neighborhood. As already mentioned, however, two of the Transit neighborhoods with relatively low transit usage actually received more intensive services, so it is not levels-of-service alone that explain differences. One possible reason why relationships are more muddled in Southern California is that it has much more of a spread-out, auto-dependent regional form. Whereas the Bay Area has dense corridors and many transit options, in part because of its topography, Los Angeles' uniformly low-to-moderate densities could swamp any influences of transit-oriented neighborhoods. Having transit-oriented neighborhoods in a region so strongly dominated by the automobile could very well be of negligible importance.

6. Regression Analysis of Aggregate Data

Because only a small number of matched pairs were found for both metropolitan areas, regression models were run for Los Angeles County and for four Bay Area counties to further elaborate on the relationship between neighborhood type and transit modal share and generation rates[22] Data from most census tracts in Los Angeles County and the four Bay Area counties which contained neighborhoods studied in this chapter were used in estimating these models[23] Census tracts were assigned to one of the two categories- Transit or Auto— based on whether their road configurations were more transit- or auto-oriented and whether they were served by rail transit in the past or presently have a rail station.[24] Fairly good-fitting models were estimated for predicting transit mode share in both regions, and transit generation rates in the Los Angeles County region. Model results are shown in Tables 5.9 through 5.11.

In all three models, residential densities had a significant positive effect on transit commuting in both Transit and Auto neighborhoods— especially in Los Angeles County. Neighborhood type was also a significant predictor. For Los Angeles County, Table 5.9 shows that, holding residential densities and incomes constant, 1.4 percent more work trips are likely to be by transit in a Transit neighborhood than in an Auto neighborhood. Also for Los Angeles, Table 5.10 reveals that for every 1,000 households, 19 more transit work trips could be expected in a Transit neighborhood than in an Auto neighborhood, holding the same variables constant. And, again holding income and density

Table 5.9
Modal Split Regression Model: Percent of Work Trips by Transit, Los Angeles County, 1990

	Coefficient	Standard Error	Significance
Gross Residential Density (HHs/acre)	3.29	0.33	0.000
Natural Logarithm of Household Income	-10.24	3.64	0.000
Neighborhood Type*	1.42	0.29	0.000
Density Interaction**	2.44	0.64	0.000
Constant	111.55	3.91	0.000

Summary Statistics:

Number of cases = 1,636
R-Square = 0.55
F = 502.8
Prob. = 0.000

***l = Transit, 0 = Automobile**
**Interaction Term = (Gross Residential Density) x (Neighborhood Type)

Table 5.10
Trip Generation Regression Model: Transit Work Trips per Acre, Los Angeles County, 1990

	Coefficient	Standard Error	Significance
Gross Residential Density (HHs/acre)	3.80	0.51	0.000
Natural Logarithm of Household Income	**-120.35**	5.52	**0.000**
Neighborhood Type*	18.94	5.35	0.000
Density Interaction**	3.05	0.97	0.001
Constant	1,318.05	59.24	**0.000**

Summary Statistics:

Number of cases = 1,636
R-Square = 0.43
F = 304.8
Prob. = 0.000

***l = Transit, 0 = Automobile**
****Interaction Term = (Gross Residential Density) x (Neighborhood Type)**

Table 5.11
Regression Model: Percent of Work Trips by Transit, Modal Split, Alameda, Contra Costa, San Mateo, and Santa Clara Counties, 1990

	Coefficient	Standard Error	Significance
Gross Residential Density (HHs/acre)	0.95	0.26	**0.000**
Natural Logarithm of Household Income	-4.80	0.55	0.000
Neighborhood Type*	5.14	0.91	**0.000**
Density Interaction**	2.75	1.17	0.019
Constant	56.70	6.06	**0.000**

Summarv Statistics:

Number of cases = 898
R-Square = 0.46
F = 187.1
Prob. = 0.000

***l = Transit, 0 = Automobile**
****Interaction Term = (Gross Residential Density) x (Neighborhood Type)**

constant, Table 5.11 estimates there will be 5.1 percent more journey-to-work trips by transit in the Bay Area's Transit neighborhoods than in its Auto neighborhoods.25 The stronger sensitivity of transit ridership to neighborhood type in the Bay Area confirms what was found in the matched pair analyses.

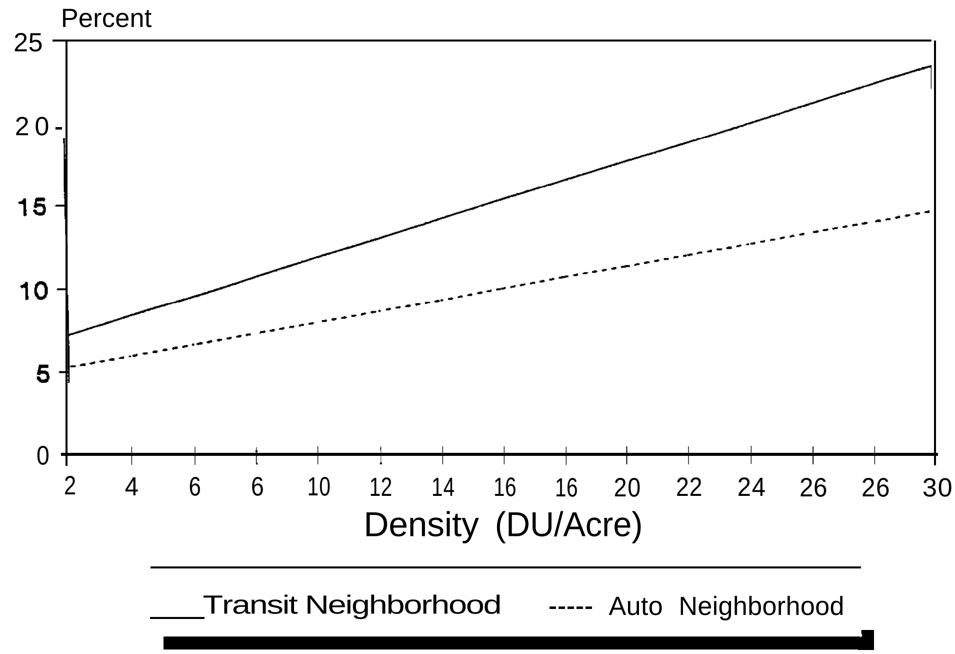
Also of interest is the fact that there was significant interaction between neighborhood type and density in both metropolitan areas. This is shown in Figures 5.9 through 5.11; all three figures plot regression lines for each neighborhood type (using median household income values for each area) 26 Interaction is revealed by differences in slopes. In the case of Los Angeles County, increases in density clearly have a stronger affect on inducing transit commuting in Transit than in Auto neighborhoods — on average, each additional dwelling unit per acre in Los Angeles' Transit neighborhoods raises the share of work trips by transit by 2-4 percentage points relative to Auto neighborhoods, all else being equal. While density had a stronger effect on transit commuting in Los Angeles County, interaction effects were stronger in the Bay Area. Figure 5.11 shows that at 10 dwelling units per acre, Transit neighborhoods averaged 8.0 percent more work trips by transit, while at 30 dwelling units per acre, they averaged 13.5 percent more transit commutes. In terms of transit trip generation rates, interactive effects were similar to what they were for transit modal splits in Los Angeles County (Figure 5.9).

7. Conclusions and Implications

The evidence presented in this chapter suggests that the distinction between traditional neighborhoods laid out originally around transit stations and more recent, automobile-centric neighborhood patterns does influence travel behavior for the commute trip. Specifically, it seems to affect the degree to which people drive alone to work, and the degree to which they walk or bicycle. Transit neighborhoods, by and large, showed lower drive-alone modal shares and trip generation rates than Automobile neighborhoods. Similarly, those we categorized as Transit neighborhoods averaged higher walking and bicycling modal shares and generation rates than their automobile counterparts.27

The effects of neighborhood types on transit commuting is less clear. In the Bay Area, transit ridership rates are higher in all neighborhoods classified as transit-oriented except Palo Alto. In Los Angeles, no clear pattern emerged with regards to transit commutes among neighborhood groups28 The regression models, however, suggest that when criteria are relaxed, stronger relationships between neighborhood type and transit modal shares and trip generation rates begin to appear. Of particular note was the finding that densities had a proportionally greater effect on inducing transit usage in transit-oriented than auto-oriented neighborhoods

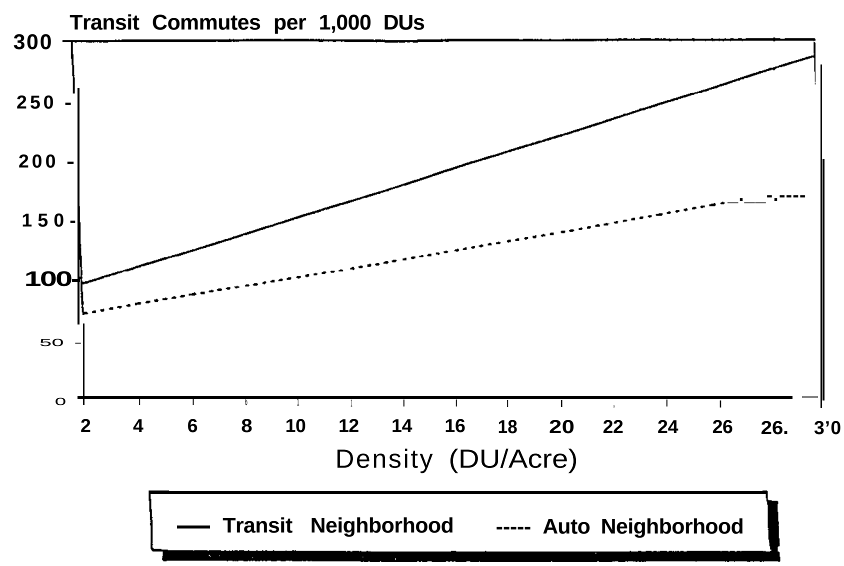
We conclude with several caveats about the endeavor to conduct matched-pair studies of neighborhoods.



For Households with Median Incomes

Figure 5.9

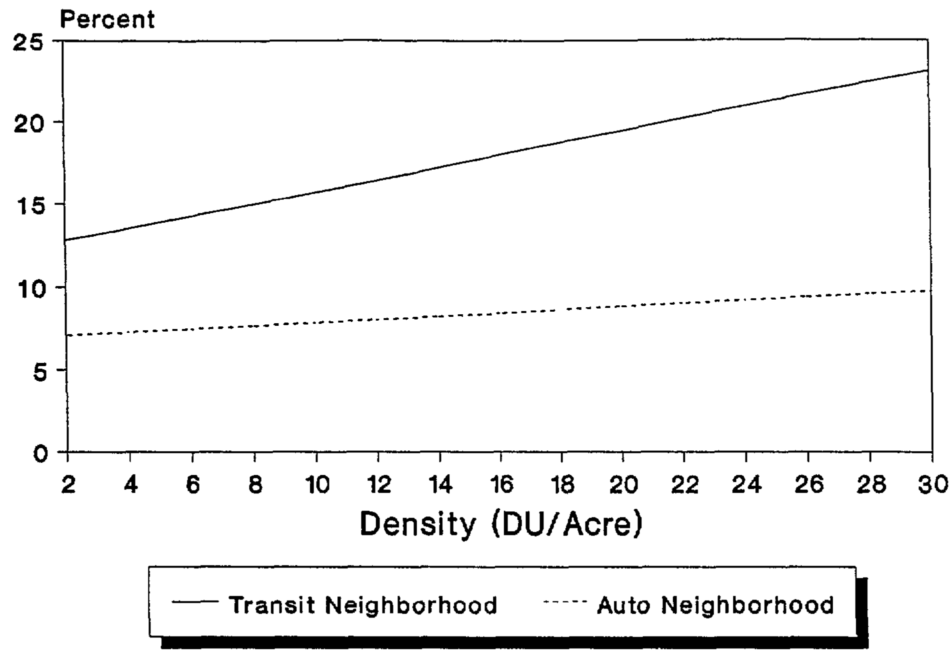
Interactive Effects of Density and Neighborhood Type on Percent of 1990 Work Trips by Transit, Los Angeles County



For Households with Median Incomes

Figure 5.10

Interactive Effects of Density and Neighborhood Type on 1990 Transit Work Trip Generation Rates, Los Angeles County



For Households with Median Incomes

Figure 5.11

Interactive Effects of Density and Neighborhood Type on Percent of 1990 Work Trips by Transit, San Francisco Bay Area

1. One of the most persistent difficulties in our method of research was the inability to find a large number of pairs matched on the basis of income. This was probably the number one reason for deciding to eliminate a census tract. Specifically, the areas we identified as being "transit-oriented" — in other words, the older, traditional communities— almost consistently demonstrated lower median incomes than the surrounding, auto-oriented areas. This pattern held for both the San Francisco and Los Angeles regions. In many cases, this income disparity eliminated the possibility of finding matches within four miles of each other.

   Further investigation of these income disparities may provide clues about the nature of American housing and transportation patterns in general, and also about the potential obstacles that neotraditional urban development may face. For example, while much of this disparity can probably be attributed to land and housing filtration market mechanisms, it opens the question as to whether traditional neighborhood patterns (gridiron streets, shorter setback allowances, etc.) are not associated in the minds of housing consumers with lower incomes and, consequently, less desirable housing. If this is the case, it may be a tougher sell for neotraditional designers and builders in the marketplace than they previously thought.

2. The research was not particularly successful in isolating the three variables of transit service (intensity), neighborhood type, and transit usage. These three elements are so closely interwoven that, in fact, it may be virtually impossible to control for transit service levels in assessing neighborhood impacts on ridership.

3. The results for the matched pair analysis for the Los Angeles metropolitan area were not nearly as strong as those for the San Francisco area. In fact, some "transit" neighborhoods in the Los Angeles region showed weaker pedestrian and transit modal shares and generation rates than their "Auto" counterparts. Because the Los Angeles region is highly decentralized, it may be that the form of the region as a whole has as great a role, if not greater, in influencing modal choice than the design or layout of particular neighborhoods. In other words, the metropolitan form of the macro-region may be too auto-centric for the micro-pattern of any particular neighborhood to matter.

4. The analyses in this chapter were conducted on existing neighborhoods by comparing turn-of-the-century, transit-oriented communities with mid- to late-twentieth century automobile-oriented communities. These existing communities have established patterns of land settlement: established residential spatial forms, established commercial layouts and patterns, established businesses and retail operations that are already known in the community, and established employment patterns.

   These conditions undoubtedly have an effect on individual travel behavior, and consequently on aggregate modal splits. But these conditions are precisely those conditions which are not applicable to new transit-oriented developments. Businesses are *not* already located there, and employees and businesses have *not* collectively had the time or the history to "find each other," so to speak. There may be more flexibility for a household to locate within a traditional transit-oriented neighborhood — in order to take advantage, for example, of a pedestrian commute to work — than there would be for the same household to locate in a neotraditional community that has just been built, precisely because of existing firm locational decisions. Therefore, it is possible that the modal share and generation rate differentials observed in the existing communities would not be observed in new transit-oriented communities. To know for sure, however, researchers will need to wait until prototype communities are constructed, and travel behavior data compiled.

5. Some research suggests that traditional transit-oriented neighborhoods have the biggest influence on non-work trips, particularly shop trips. Holtzclaw (1990, Handy (1992), and Ewing (1993) found traditional neighborhoods averaged either fewer VMT per capita or higher shares of short walk trips than 1970s-style PUDs Handy (1992) found, in particular, that traditional neighborhoods were conducive to internal (local access) walk and bicycle trips. However, for external (regional access) shopping trips, there was little difference in average trip length or modal splits between types of neighborhoods. Thus, people wanting to leave a traditional neighborhood were just as likely to drive their car as someone from a more auto-oriented neighborhood. Since the analysis presented in this chapter focused solely on work trips, which tend to be external to a neighborhood, the absence of any strong relationships, at least for Southern California, is totally consistent with the findings of other researchers. If the matched-pair comparisons were carried out for shop and other non-work trip purposes, differences in modal splits and trip generation rates could very well have been far more significant. This is an important area for future research.

Notes

1 One scenario assumed absorption of the new growth areas into the regions' largest urban centers. The other assumed the new growth areas would stand alone as areas of settlement.

2 Initially, we had included a mixture-of-use criterion, to approximate the neotraditional planning idea of having more integrated, less "magic-marker-zoning" style, land-uses. We found, however, that many potential "traditional" neighborhoods were eliminated immediately, because many of them are single-use. In addition, attempts at quantifying this mixture of use (using an entropy index) did not address the qualitative issues behind urban designers' emphasis on mixture of use: many automobile-centric neighborhoods with strip shopping streets still showed up quantitatively as "mixed-use," although they hardly exemplify contemporary standards of "mixture of use."

3 Or, indeed, if transit operates in these neighborhoods simply because of historical precedent and inertia. When the private streetcar companies were dismantled, frequently local or county governments stepped in immediately with newly established transit agencies whose mandate was to take up the transportation service the private companies had just abandoned. Most often, this meant paralleling with buses service that had previously been provided by trains or streetcars. Subsequently, inertia or resistance to change by riders, neighborhood groups, or politicians may have insured that the routes remain in their existing alignment.

*Our indicator for relative level of bus transit service was calculated as total daily transit vehicle miles traveled through and within l/4 mile of the study area, divided by the acreage of the study area (Daily Bus VMT per acre). Because of the difficulty of finding older transit maps and schedules, we calculated the transit intensity indicator based on 1993 service levels, even though the modal choice data were from 1990. We felt that 1993 schedules and routings were adequate enough to give a sense of relative intensity of transit service between the pairs, even if they are not good indicators of the actual situation at the time. Rail transit intensity was not calculated, but has been noted where present. Generally, we looked to pair neighborhoods within l/4 mile of a rail transit stop together, but in some instances (downtown Mountain View, for example) this was not possible. The primary shortcoming of our transit intensity indicator is that it does not provide a comparative indicator of the degree to which actual transit service approximates commuter desire lines for the areas studied. Clearly, however, such an indicator is beyond the purview of this project.

5 We did allow one exception to this rule, a comparison between Rockridge and Lafayette, which, while separated by five miles, are both located along the same segment of the BART system, yet are each excellent examples of the types of neighborhoods examined in this study. In the interest of allowing that comparison, the pairs were included in the analysis.

6 We used a net residential density figure calculated by subtracting from the total land area (obtained from the Census) the amount of land we estimated to be used not for residential purposes (obtained by windshield surveys and clues from maps), giving us net residential acreage. The density then was calculated as dwelling units per net residential acre. We tried to obtain more accurate density information, along with information about land-uses. However, Land-Use inventories are not yet complete for the Southern California region. The Association of Bay Area Governments does have land use inventories available for the Bay Area. However, these are available only at the tract level. Since we have some areas that require Block Group-level data, we would have been unable to consistently use ABAG's inventory and density information. It was decided, therefore, to use the rougher but more consistent method of estimating net residential areas described above.

7 As noted above, the strictness of the criteria revealed only relatively few viable matched pairs for the two metropolitan regions. The reasons for elimination of neighborhoods from scrutiny, in order of importance, were: (1) The geography of the census data was incompatible with this type of study- that is, the areas that could be defined as traditionally transit-oriented did not conform to any census boundary that made it usable (either as a census tract or a block group). We had this difficulty particularly in the North Bay region of the San Francisco area (Marin, Sonoma, and Solano counties), where census tracts and even block groups were much bigger or differently shaped than the traditional core of the city. (2) No matches could be found that met the 10 percent variation in median income criterion and still fall within our distance criterion. We encountered this difficulty particularly in the Diablo and Livermore Valleys in the San Francisco area (Alameda and Contra Costa counties), as well as in San Rafael in Marin County. We also encountered this sort of problem sporadically in the LA region. (3) Level of transit intensity did not match up. A number of areas in the Los Angeles area (Pasadena, Glendale) needed to be eliminated because of this criterion. While we did not set strict limits, we eliminated pairs

that were unreasonably different in service intensity. Because VMT per acre is likely not the only indicator of relative transit accessibility for a neighborhood, we decided to show the data for the pair even if it had noticeable differences in VMT per acre, provided they were not unreasonably excessive. (4) Some neighborhoods were eliminated from consideration for other reasons, such as unmatchable topography or excessive distance to employment centers.

8It should be noted that several factors likely influencing mode choice were not taken into account in our study. First and probably most important is safety. We controlled neither for relative safety between the matched pairs, nor for relative perceived safety. Perceptions of safety, both of the neighborhood and of the bus route, may play a significant role in explaining modal choice and transit usage, particularly in Los Angeles. A second group of factors not taken into account was aggregate household factors besides median income: average auto-ownership rates in the study areas, average number of working adults per household, age composition of the study areas, etc. Income, however, probably serves as a proxy for many of these additional variables.

9The “downtown” area of Palo Alto for the purposes of this study is the portion bounded by Alma Street, Oregon Page Mill Expressway, Middlefield Road, and San Francisquito Creek. This corresponds to Census Tracts 5113.98 and 5114.98. The Mountainview neighborhood is bounded by the Central Expressway (an extension of Alma Street), North Shoreline Boulevard, the 101 Freeway, and the 85 Freeway. This corresponds to Census Tract 5092.02.

l0The Santa Clara area studied is bounded by Civic Center Drive, Sherman Street, Park Avenue, the San Jose border, and Pierce and University Streets. This corresponds to Census Tracts 5056 and 5057. In San Jose, the study area is bounded by Stevens Creek Boulevard, the 17 Freeway, Williams Road, and Winchester Boulevard. This corresponds to Census Tract 5064.01.

llThe downtown area zigzags from Tilton Avenue and El Camino to 10th Avenue and the 101 Freeway. This corresponds to Census Tract 6063. The Bayshore Point study area is bounded very simply by the Golf Course on the north, the Bay on the east, Hart Clinton Drive on the south, and the 101 Freeway on the west. This corresponds to Census Tract 6061.

12The Rockridge neighborhood is bounded by Claremont Avenue, the BART tracks/Highway 24, Patton Street, Roanoke Road, and the Berkeley/Oakland border. This corresponds to Census Tract 4002. The Lafayette neighborhood is bounded by Acalanes Road, the Lafayette/Orinda border, the Lafayette Moraga border, Moraga Road, and the BART tracks/Highway 24. This corresponds to Census Tract 3500 (Lafayette portion only).

l3The Mountain View neighborhood is bordered by Central Expressway, South Shoreline Boulevard, El Camino Real, Bush/Dana Streets, and Calderon Avenue. This corresponds to Census Tract 5096. The Sunnyvale neighborhood is bounded by El Camino Real, Mary Avenue, the Southern Pacific Railroad, and the Mountainview/Sunnyvale border.

l4The San Mateo-King Park area is bordered by the 101 freeway, Poplar Avenue, the Southern Pacific Railroad, 1st Avenue, Delaware Street, and 4th Avenue. This corresponds to Census Tract 6062. The Millbrae area is bounded by San Francisco International Airport, the Millbrae/Burlingame border, Magnolia Avenue, Taylor Boulevard, Broadway, Magnolia Avenue, and the Millbrae/San Bruno border. This corresponds to Census Tract 6044.

l5The central San Leandro neighborhood is bounded by San Leandro Creek, Bancroft Avenue, Warren Avenue/ Marina Boulevard, and the Southern Pacific Railroad. This corresponds to Census Tract 4326. The Bayfair neighborhood is bounded by Hesperian Boulevard, 150th Avenue, the I-580 freeway, 159th Avenue, 14th Street, Ashland Avenue, and the I-880 freeway. This corresponds to Census Tract 4338.

l6The central Santa Ana neighborhood is bordered by the I-5 freeway on the northeast, the Santa Fe Railway line on the east, Pine, Garfield and 1st Streets on the south, and French Street on the west. This corresponds to Census Tract 744.05. The Center Park neighborhood is bounded by Willits Street, Fair-view Street, 5th Street, and Raitt Street. This corresponds to Census Tract 748.02

17Central Orange is bounded by Walnut Avenue on the north, Cambridge Street on the east, La Veta Avenue on the south, and the Santa Fe Railroad/Chapman Avenue/Batavia Street on the west. This corresponds to Census Tracts 759.01 (all) and 759.02, Block Groups 1,3, and 5. The Garden Grove study area is bounded by Simmons Avenue, Lewis Street, Garden Grove Boulevard, and Haster Street. This corresponds to Census Tract 761.03.

18 Central Norwalk is bounded by: the I-5 freeway, Pioneer Boulevard, Foster Road, Kalmor Street, Pioneer Boulevard, and Rosecrans Avenue. This corresponds to Census Tracts 5521, Block Group 2, and 5522 (all). The Downey subject area is bounded by Firestone Boulevard, Lakewood Boulevard, Steward and Gray Road, and Paramount Boulevard. This corresponds to Census Tract 5513.

19 The La Verne study area is bounded by B Street, 8th Street, White Avenue, and Bonita Avenue. This corresponds to Census Tract 4016.02, Block Group 2. The Pomona-County Fairgrounds study area is bounded by the I-10 freeway, Dudley Street, Laurel Avenue, and Huntington Blvd. This corresponds to Census Tract 4023.01

20 The central Claremont study area is bounded by Foothill Boulevard, Indian Hill Boulevard, 4th Street, Yale Avenue, Bonita Avenue, Harvard Avenue, 7th Street, College Avenue, 12th Street, and Dartmouth Avenue. This corresponds to Census Tract 4019.02, Block Group 1. The Pamona-Palomares neighborhood is bordered by the Atchison, Topeka, Santa Fe Railroad, Towne Avenue, the I-10 freeway, Mountain Avenue, Arrow Highway, and the Pomona/Claremont border. This corresponds to census tract 4021.01.

21 The central San Dimas study area is bounded by San Dimas Avenue, Bonita Avenue, Amelia Avenue, and W. 5th Street. This corresponds to Census Tract 4013.11, Block Group 2. The Covina study area is bounded by Glendora Avenue, Puente Street, Barranca Avenue, and the Southern Pacific Railroad tracts. This corresponds to Census Tract 4037.22.

22 The four Bay Area counties were those that contained the seven paired communities -Alameda, Contra Costa, San Mateo, and Santa Clara Counties.

23 Census tracts with near-zero land area (called “sliver tracts”) or zero population were eliminated from the analysis.

24 Transit census tracts were considered to be those with percent of four-way intersections that were 25 percent above the countywide averages. Auto census tracts, on the other hand, were all remaining ones with below-average shares of four-way intersections. In the regression models, density was measured in terms of gross residential density -the number of housing units in a tract divided by the tract’s gross land area in acres.

25 These regression models, it should be noted, do not maintain the same degree of control as the matched pair analysis. First, intensity of transit service was not a variable in the regression analysis, because of the absence of county-wide indicators. Second, the density variable was based on gross, not nee, residential densities. Again, this was due to the lack of adequate region-wide indicators.

26 The 1990 median household income for Los Angeles County was $34,220. For the four Bay Area counties, it was $42,670.

27 Although there are too few pairs here for a statistical test to be of real value, we did run a matched pair t-test for all the pairs in the sample, and found these differences to be statistically significant at a 5 percent probability level. The drive-alone modal shares showed a mean difference of .07 with a t-value of 3.30. The drive-alone trip generation mean difference was 158. This had a t-value of 4.16. The pedestrian/ bicycling modal share mean difference was .06, with a t-value of 2.97. And the pedestrian/bicycling trip generation mean difference was 52, with a t-value of 3.84.

28 The matched pair analysis showed no significant relationship between the paired differences of observed transit modal share and generation rates, and neighborhood type.

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